

COLLECTION OF PAPERS
DEALING WITH THE
FISHERY SURVEY
OF THE
BAY OF BENGAL.

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**EXTRACT FROM THE PRELIMINARY REPORT OF
THE 20th FEBRUARY 1907 ON THE FISHER-
IES OF BENGAL,**

**By MR. K. G. GUPTA, I.C.S. (now SIR KRISHNA G. GUPTA,
I.C.S.I.), Member, Board of Revenue, *on special duty.***

SEA FISHERIES.

The physical features of the Bengal coast have already been described. Foreshore fishing is carried on only in calm weather, *i.e.*, from October to about the middle of March. Such fishing is unimportant except in Balasore where there are seven main fishing stations along the coast, Chandipur being the best-known of them. Fishing during this period is done there only by means of fixed nets (*malá*) in which fish are caught twice daily during ebb-tide. The catches are of all sorts, varieties and sizes, including young sharks and skates, crabs, etc. Good fish, such as bhetki, mugils polynemus, and clupeas, form a fair proportion of the catch. Some of the fish is sold locally, some sent fresh to Calcutta, and the rest is dried for export; but unlike Cuttack and Chilka, no salt is ever used. During the rest of the year a certain amount of fishing is done by means of a long but very narrow (less than a foot) net (*kat/ia*), which is dragged by two or three men in knee-deep water.

There is no deep-sea fishing anywhere in Bengal, except in Puri which alone has got an open coast. Even there such fishing is of the most limited extent, and is carried on, not by local Urya fishermen, but by Telugu settlers from Ganjam called Nulias. In Puri there are some 400 families of Nulias inhabiting eight hamlets. During the calm months they use the seine net and at times make excellent hauls, *bijram* (Madras seir, *cybium guttatum*), pomfrets, small soles, etc., being among the fish caught. A kind of herring is also found in abundance.

During the cold weather, there is a small export of fresh fish from Puri town to Calcutta. The rest is either sold locally or dried for export. With the seine net the fishermen cannot go far out, seldom more than half a mile, as one end of the rope to which the net is attached is left on the beach where the net is eventually hauled. With

small gill nets or hooks and lines the Nulias go to a distance of two or three miles in calm weather in catamarans, but the catches are small. During the prevalence of the south-west breeze when the seine cannot be used, a little fishing is done with gill nets not far from the beach, but all deep-sea fishing practically ceases from about the middle of March to about the middle of September.

The abundance and variety of sea fish caught with the rudest and most primitive of appliances on the foreshore in Balasore and in the open sea in Puri indicate the wealth of marine life that may reasonably be looked for in the deep sea, for big shoals seldom come quite close to the beach and the catches merely represent stragglers from schools and younger members of the larger kinds.

FISHES CAUGHT IN THE SEA AND ESTUARIES.

I.—Of Elasmobranchs (chondropterygii)—

- | | |
|---|--|
| (1) <i>Zygæra blochii</i> (julia
magar), | (4) <i>Aëtobatis narinari</i> (sanka
chil), |
| (2) <i>Pristes cuspidatus</i> (khan
da magar), | (5) <i>Rhynchobatus djedden-
sis</i> , |
| (3) <i>Pteroplatea micrura</i>
(kulta), | (6) <i>Urogymnus asperrimus</i> , |
| | (7) <i>Trygon sephen</i> , |

and several others are caught.

II.—Teleostei—Of *Pisces*—The family *Symbranchidæ* supplies *Amphipnous cuchia* (kuchia) which are found and caught extensively in brackish water.

Of family *Siluridæ*—(1) *Plotus canius* (kan magur), (2) *Arius gagora* (gagat), (3) *kentengus typus* (meda) and a few others are exclusively brackish, but many of the fresh water representatives are also found in the estuaries and sea. *Bagarius yarrellii* (Bag Air) attains 6 feet.

Carp are entirely absent, but the *Clupeidæ* are very well represented. *Clupea ilisha* (hilsa), *Opisthopterus tartoor* (tarture), *Raconda russelliana* (kura phasa), *Engraulis hamiltoni* (phasa), *E. telara* (Tel tampri), *E. indicus* (kagaja), *Chatoessus nasus* (Barang), *Coila dussumieri* (oorialli), *Chanos salmoneus* (sabá), *Clupea kanagurta* and *C. fimbriata*.

The only representative, *Chirocentrus dorab* (khandá), of family *Chirocentridæ*, is very largely caught and consumed.

Family *Scopelidæ*—*Harpodon nehereus* (Bombay duck) and *Saurus myops* (koniari).

Family Scombretoideæ—*Hemirhamphus cantori* (gangturi), *H. ectuntio* and *Exocoetus pasciapterus* (flying fish) are caught and sold.

Of *Acanthopterygii*, the sea claims numerous representatives, most of which are very valuable as food.

Of the family *Percidæ*—

- (1) *Lates calcarifer* (bhetki),
- (2) *Cromileptes altiveles* (khaibel),
- (3) *Serfanus sonnerate* (son bhetki),
- (4) *Lobotes surinamensis* (somudra koiu),
- (5) *Gerres filamentosus* (jagiri),

are all of large size and highly valued as food.

Of family *Squamipinnes*—

- (1) *Scatophagus argus* (Rupchanda),
- (2) *Drepane punctata*,

are very much sought after and always command a good price.

Of family *Sparidæ*—

- (1) *Chrysophrys datina*,
- (2) *Pagrus spinifer* (khuranti),
- (3) *Crenidens indicus* (Kala khuranti),

are largely caught and are considered good eating.

Of family *Nandidæ*—*Nandus marmoratus* is the only brackish water fish (which is occasionally also found in the fresh waters, *i.e.*, *Bodosi* of Orissa), which is largely caught and eaten.

As a family, *Polynemidæ* is very important, though having only a few representatives in the Bengal seas. *Polynemus paradiseus* (among fish, *P. indicus* (chhela of 24-Parganas and sahal of Orissa). Other species reported are *Polynemus xanthonemus*, *P. sextarius*, *P. sexfilis*, *P. plebeius*, and *P. tetradactylus*.

Of family *Sclænidæ*,—*Sciæna cuja* (danteena), *S. coitor* (bhola), *Scavenoides pama* (koi bhola), *Otolithus maculatus* (beriali) are caught, but not much esteemed as food.

Of *Trichiuridæ*—*Trichiurus muticus*, *T. haumela* and *T. savala* (rupa patia) are caught and command a good price.

Of the family *Caransidæ*—(1) *Chorinemus moadetta*, (2) *C. lysan* (Taliapara or kárisa), (3) *Psettus argenteus* (chanda), (4) *Platax teira*, (5) *Equula edentula* (tauka

chanda), and (6) *Equula blochii* are esteemed as food and are largely caught.

Of the family *Stromateidæ*—the important species caught are *Stromateus sineusis* (white pomfret), *S. cinereus* (adult-grey pomfret) (immature-silver pomfret), *S. niger* (Báhál of Orissa)—all these are considered very good eating.

Of the family *Coryphænidæ*, the only species, *i.e.*, *Mene maculata* (chanda) always commands a good market and is largely caught.

Of the family *Scombridæ*—*Thynnus thunnia*, *Pelamys chilonensis*, *Cybium commersonii* (champa), *C. guttatum* (Madras seir) are important.

Of the family *Trachinidæ*—the most important species caught is *Sillago panius* (Guj karma). It ascends rivers and tidal estuaries, and is considered light and wholesome food.

Of the family *Gobiidæ*—*Gobius kokius* is the sea and estuarine representative of *Gobius giuris* of the fresh water. *Apocryptes bat* (Rutta), *Periopthalmus keolreuteri* and *Periopthalmus schlosseri*, *Boleophthalmus viridis*, *Eleotris fusca* (Balia), *E. amboinensis*, *Gobiodes anguillaris*, *G. cirratus*, *G. buehanani*, *G. rubicundus* are the representatives of the several species, which are known by the general name Bê'e and are largely caught and eaten.

Of the family *Rhynchobdellidæ*—*Rhynchobdella aculeata* (Tara báim), *Mastacembelus unicolor* (Pákál), *M. zebrinus* (Ráj Pákál), *M. pancalus* (Gochi pákál) are excellent as food and are found both in fresh as well as brackish waters.

Of the family *Mugilidæ*—*Mugil tade* (Bhangon) and *Mugil oeur* (Ash Bhagon of Calcutta and Khoyenga of Orissa) are very largely caught and much prized as food. Dried khoyenga roe is considered a delicacy. *Mugil parsai* (tarui) is a small *Mugil* (5" to 6") and is largely caught.

Among Anacantheni the family of *Pleuronectidæ* is the only representative in the sea and estuaries of Bengal. They are all flat fishes (soles). The important species caught are—

- (1) *Solea ovata* (kántál páttá),
- (2) *Sanaptura pan*,
- (3) *Cynoglossus bengalensis* (kukurjibh),
- (4) *C. hamiltonii* (Báns-pátá), and
- (5) *C. brevis*.

Of the order Plectognathe—

- (1) *Triocanthus brevirostris*,
- (2) *T. strigilifer*,
- (3) *Tetrodon lunaris*,
- (4) *T. patoca*, and
- (5) *T. cutcutia*,

are reported, some of which are utilized as bait for crabs.

ECONOMIC VALUE OF DIFFERENT KINDS OF FISH.

There are some varieties which are found in both fresh and brackish water, the best known of which is the hilsa (*Clupea ilisha*). Among the others are—

Air (*Macrones aor*),
Boali (*Wallago attu*),
Silond (*Silondia gangetica*),
Pangas (*Pangasia buehanani*),

all of which grow to a large size and are gross feeders, especially the last. Rita (*Rita buehanani*) is smaller, but comes under this group.

Elanga called also arwari (*Mugil corsula*) is a well-known and delicious fish which is found very high up.

Tengra (*Macrones vittatus*) and Bele (*Gobius giuris*) are not large in size, but great quantities of them are eaten.

Of the estuarine and sea fishes, none is better known or more esteemed than bhetki (*Lates calcarifer*), and topsi or mango fish (*Polynemus paradiseus*), and the following also are of great value:—

Bhangon (*Mugil tade*).
Khonga or ash bhangon (*M. oer*).
Dangri or danglea (*M. Belanak*?).
Parsia or taoroi (*M. parsia*).
Tel tamri (*Engraulis telara*).
Tarui bhangon, guchhia or sahal (*Polynemus indicus*).
Kan magur (*Plotosus canius*).
Khaira (*Clupea fimbriata*).
Ekthute (*Hemir amplus Cantari*).
Khuranti or datina (*Pagrus spinifer* and *Chr, sophrys datina*).

Sobha (*Chanos salmoneus*) is found occasionally in the Chilka. It is a clupea, and the Raja Bahadur of Purikud assured me that as regards taste and flavour it is the best of all fishes. It is found largely in Southern India.

Chanda is a term loosely applied to several varieties belonging to different families, such as Stromateidæ, Squamipinnos, Carangidæ and Coryphænidæ. Some of these are true pomfrets (Stromateus) and come from Balasore and Puri, but they are generally small in size.

Among the purely marine varieties are son bhetki (*Serranus sonnerata*), samudra koi (*Lobotes surinamensis*), rupapatia or ribbon fish (*Trichiurus haumala*) and several species of polynemus.

Bijram or seir (*cybium guttatum*) and other fish of Scombridæ family and some representatives of Pleuronecidæ (soles) are found along the coast. But they are usually of small size and chiefly of value as indicating their presence and showing that with proper appliances for deep sea fishing more successful hauls could be made.

Bombay duck (*Harpadon nehereus*) is by no means rare, especially at the Sandheads; if it could be brought into Calcutta fresh, it would find a ready market.

Eels which come under different families are found in both fresh and brackish water, especially in the estuaries, and are consumed to a large extent.

The estuaries and tidal rivers abound in crustacea, of which the principal are shrimps, prawns and crabs. During the rainy season the waters are often thick with the young of crab, which must furnish abundant food to many kinds of fish. Good sized crabs are found throughout the Sundarbans, but the best and largest are caught in the Chilka, in small bamboo traps; *Sukura* (*Triacanthus brevirostris*) which is plentiful, but is never eaten, being used as bait. There are special fixed nets with very fine meshes for catching shrimps, and the hauls are sometimes so large that in Balasore they can then be had for less than half-an-anna per seer. Prawns of all sizes, some as big as lobsters, are abundant and always find a ready sale. Both shrimps and prawns are also sold in a dry state. Crabs are seldom found in fresh water, and shrimps and crayfish are met with in limited numbers.

Molluscs which are so largely consumed in many countries are in Bengal wholly neglected, even the poorest classes seldom touching them. They, of course, furnish food to fish, and the dried shells are collected and burnt for lime, but they have no other economic value. Oysters are found at Manikpatna on the Chilka, and a few places on the Cuttack coast, such as Satbhaya and False Point, but the

beds are not looked after, nor is any attempt made to create a market for them.

Although skates and sharks get caught in large numbers along the Orissa coast, especially in Balasore, their flesh is seldom eaten and they are simply thrown away. Sharks do not usually ascend the rivers, but skates travel long distances. In Lower Bengal skates are sometimes eaten, but in Bihar skates, crocodiles and the mammal porpoises are regularly pursued by the Banpars who eat their flesh and make oil from their livers.

BY-PRODUCTS OF FISH.

The by-products of fish, though of great value, are little utilized in Bengal. The trade in them falls under the following heads:—

- | | |
|---------------|-----------------|
| 1. Isinglass. | 4. Oil. |
| 2. Fins. | 5. Whips. |
| 3. Skins. | 6. Fish manure. |

1. *Isinglass*.—This is prepared from the sounds or air bladders of certain fishes, that obtained from the sturgeon being the true article. In Lower Bengal the sounds of a few kinds of Arius (e.g., *A. gagora*) are collected for the purpose. In Orissa very good sounds can be had from the Nakora (*Polynemus indicus*) and Son bhetki (*Serranus sonnerati*) and a small business is done in them in Balasore, but in Cuttack and Puri it is practically unknown. There is a good opening for any one with a small capital who is prepared to take it up. At present a valuable economic product is literally thrown away. There is a great demand for sounds in China and they can also be exported to Europe.

2. *Fins*.—Shark's fins are greatly prized in China and large quantities are exported there from Bombay and Karachi. It is a pity that nothing is done in Bengal to foster this trade. A great number of sharks and skates are caught daily in the cruives spread out along the whole of the Balasore coast from October to the end of February, but they are entirely thrown away, no use whatever being made of their flesh, fins, skin or oil.

A similar waste takes place in Puri, but there the number caught is small.

3. *Skins*.—Skates go up the larger rivers and some of good size are often caught in the Ganges in Bihar. But as

far as I know, no use is made of the skin. The true alligator is unknown in India, its habitat being America. The two varieties of crocodiles that are common in the rivers of Bengal are—

- (1) *Gavialis gangeticus* (gharial) with an extremely elongated snout. Feeds entirely upon fish.
- (2) *Crocodylus palustris* (kumir, short snout, often man-eaters).

Numbers of them are killed, and in Bihar they are regularly hunted by Banpars, a low caste people, for their flesh and oil, but the skin is not preserved. A gentleman of my acquaintance who has large opportunities of shooting crocodiles tried to ascertain whether the skins had any marketable value, but met with a disappointing response. The matter, however, is deserving of further enquiry. Crocodiles destroy much fish life, and if a profitable trade could be found for their skins, there would be strong inducement to kill them systematically.

Tortoises of all sizes and varieties are very common. Their shells, which are now thrown away, should have a commercial value.

4. *Oil*.—In former times, before the introduction of kerosine oil, fishermen in those parts of the country where fish was cheap and abundant, used to prepare oil from various fishes, chiefly for burning, and this practice still continues, though on a much reduced scale in the poorer localities. Oil is made from the liver of skates and porpoises for burning as well as for medicinal purposes, it being considered a good remedy for rheumatism.

5. *Whips*.—The long tails of some varieties of skates are used for the preparation of whips.

6. *Fish manure*.—The demand for fish for eating is so great that there is seldom any waste, but when the catches cannot be wholly disposed of, the surplus is utilized in Darbhanga and Muzaffarpur as manure for the more valuable fruit trees, such as mango, lichu, lime, vine, etc., and in Shahabad occasionally for gardens.

FISH SUPPLY—GENERAL DECREASES—CAUSES.

The estuarine and sea fisheries stand on a different footing. The former are still imperfectly worked; they are replenished from the sea and there is little fear of their exhaustion within any measurable distance of time. The

foreshore has barely been touched and the ocean still waits to deliver up its riches. There is no doubt that an inexhaustible supply can be obtained from these two sources by improved methods of capture and transport.

EXTRACT FROM THE FINAL REPORT OF THE
27TH JANUARY 1908, REGARDING FISHERY
MATTERS,

By MR. K. G. GUPTA, I.C.S. (now SIR KRISHNA G. GUPTA,
K.C.S.I., Member, Board of Revenue, on special duty).

As will appear from my preliminary report of February last, there is no open sea-fishing to speak of along the Bengal and Orissa littoral, though from the catches made on the foreshore of Balasore and elsewhere, from the swarms that come up the estuaries and from the voyages of the R. I. M. S. *Investigator*, there is every reason to think that the Bay is full of valuable food-fish. The intermittent attempts made in previous years to fish in the Bay failed mainly because they were made without a knowledge of the habits and life history of the fish inhabiting the Bay, and above all, in complete ignorance of the banks and grounds where alone the fish are to be found in any number. In Europe and America where the seas are regularly fished, the great fishing banks are well known, as a result of the experience of many years, and fresh grounds are broken from time to time. As a first step towards the opening up of sea fisheries, it is essential that Government should undertake a systematic survey of the Bay from the fishing point of view, so that the favourite haunts and the periodical migrations of the fishes may be ascertained and recorded and practical demonstration given as to what the sea is capable of yielding; and when the results are satisfactory, private enterprise is sure to come forward and take up the business on commercial lines. It is of importance to find out where the more valuable bottom fish congregate, and where and when great shoals of migratory fish appear, for without a previous knowledge of these facts no attempt to catch them can succeed. Most of the food fishes are gregarious, and whether preferring to crawl below, as the flat fish, or swimming near the surface, as the herring or mackerel, they are usually found in shoals, which makes their capture easy of accomplishment. It is necessary for Government to make the proposed survey, since the initial outlay will be considerable, and there will be no immediate return and the results will be available to the public at large.

For this work a vessel of the type of the latest steam trawlers used on the East Coast of England and Scotland would be suitable; and it will be necessary to bring out a staff of expert fishermen from England with the necessary appliances, such as otter trawl, seines, drift or gill-nets and long lines and hooks, which constitute the chief implements of fishing there.

For the proposal I make Cape Colony furnishes a successful and appropriate precedent. Until recently it had no deep sea fishing to speak of. The Government bought a steam trawler, obtained the services of a suitable staff and commenced a systematic investigation of the coast, with the result that several valuable banks have been discovered where steam trawlers owned by private parties are now engaged in fishing.

The name of the pioneer exploring vessel of the Cape Government is *Pieter Faure*. She was the first to introduce the otter trawl in those seas and has also discovered some important fishing grounds. She has been the means of exposing the inadequacy of the old methods and securing the adoption of the latest methods. The finding by her of inshore fishing areas is satisfactory enough, but the fact that great banks have been found suitable for deep sea fishing is of far greater importance. She has also made experiments on transport by means of ice, and with a fair measure of success.

In working a vessel by Government agency, the chief object to be kept in view is not the amelioration of the condition of the fishermen or the enriching of fishing syndicates, but the opening up of a great supply of food material, which has been hitherto overlooked or neglected, for the people of the country.

The department should have a vessel, specially built to order for carrying on the work of exploration and investigation, like the *Albatross*, belonging to the Fishery Bureau of the United States. It is possible that no success may be immediately attained, but the attempt should be persisted in for a long time and given up only in the event of all hope of a favourable issue disappearing.

In the preliminary report reference was made to the climatic difficulties that seemed to beset any attempt to work the sea fisheries of

Bengal, and a doubt was expressed as to the possibility of developing them to any great extent in the near future, especially as the coast was so difficult of approach and so signally devoid of suitable harbours. The observations then made still hold true so far as fishing with sailing craft is concerned. In America steam is seldom employed in deep-sea fishing and sailing schooners of 75 to 125 tons go out many miles, as far as Labrador and Newfoundland; the coast, however, is abundantly supplied with excellent harbours at short distances. In Great Britain sail is being largely replaced by steam; nevertheless the number of fishing sailers is still very considerable. But in the Bay of Bengal it is out of the question to attempt fishing with sailing vessels except during the four or five months of the cold weather.

After studying the work of steam trawlers in Hull and Aberdeen, it seems to me that there is a great opening for them in the Bay of Bengal. They are remarkably safe and seaworthy, so much so, that they are compared with life boats; and although they visit such inhospitable shores as those of Iceland and are out throughout the year, often in most inclement weather, casualties among them are seldom heard of. They are not of any large size, 120 to 300 tons, with a draught of less than 10 feet and a speed of 9 to 12 knots an hour. They ought to stand the worst south west monsoon of the Bay with ease, and as the bad cyclones are confined to two months, *viz.*, May and October, and seldom approach without warning, a sound steam trawler should, with ordinary precautions, be able to fish in the Bay and the adjacent seas throughout the year. There would also be occupation for steam trawlers in some of the larger estuaries.

If the proposed survey of the Bay should, as it is hoped, result in the discovery of the presence of good fish in paying quantities, it is reasonable to expect that private enterprise will step in, and the great question of a plentiful supply of wholesome fish will be solved.

The implements of capture used in deep-sea fishing in Europe and America fall under three classes, *viz.*—

- (1) Otter or beam trawl.
- (2) Drift or gill nets.
- (3) Lines and hooks, comprising (a) long trawl or set lines, and (b) hand lines to which harpoon for sword fish may be added in America.

All the above, with the exception of trawls, are not unknown in this country, but those in use here are small and of faulty construction, and must be greatly improved before they can be used in the sea. It will be for the Government exploring vessel to ascertain by experiment which of the above appliances would be most suitable for particular kinds of fish and for particular localities in the bay and the estuaries. One of the most effective appliances in use in the estuaries and lakes of America is the pound-net to which reference has already been made. It is far better than the *mal* used on the Balasore coast or the *jān* found on the Chilka, for it goes into deep water, and its introduction in our estuaries would be a great advantage. It could also be used in the inshore of various parts of the coast, such as Midnapore and Balasore. I do not advocate its employment in the confined waters of the Chilka, as being too destructive and exhausting.

Assuming that the fish has been found and caught, there will arise the question of transport.
 *Transport of fish. The practice of steam-trawlers and all fishing schooners is to return to port with their catches, discharge their cargo, refit and go out again. When there is a large fleet of steam-trawlers belonging to the same firm, a tug, cutter or carrier steamer, is sometimes employed to visit the fishing grounds, collect the catches and bring them to port. But in Bengal it will be many years before such a development of the trade as will necessitate the employment of cutters can be looked for. For some time to come the trawlers must return with their own catches. In Europe and America all the fish caught in the open sea are brought dead, seldom alive. They come either fresh, preserved in ice, or partly cured in salt. The former is the more usual practice. In a hot climate like ours there must be a very liberal provision of ice, and the exploring vessel will have to make experiments as to the proper quantity of ice to be allowed for keeping the fish sound and fresh. Should the trade develop there must be a separate wharf or jetty in Calcutta for the use of trawlers, or better still, a portion of the Kidderpore dock should be prepared as a fish market for the receipt and disposal of fish and for the accommodation of trawlers, special railway and other facilities being given for the rapid conveyance of fish to the retail stalls in different parts of the city, and for despatch up country. Diamond Harbour and Port Canning may also be used as depôts for the landing and distribution of

sea and estuarine fish, but it is unnecessary here to look so far ahead.

Gasolene and petrol boats which are finding increasing favour in Europe and America would be very suitable here both in our estuaries and rivers. The mechanism is simple; it does not take up much space and is not expensive. It can be adapted to both large and small boats. Gasolene boats would be particularly useful in the rapid carriage of fish from the fishing grounds in the Sundarbans and in *kilea* fishing.

For preserving fish there must be a sufficiency of reasonably cheap ice, and in order to save the cost of carriage, the ice factory must be located close to where the fishing vessels may moor so that crushed ice may be put on board direct from the factory by means of shoots.

There can be no curing or drying without salt. In all preservative processes and in all curing factories salt is the chief ingredient used. Salt must be cheap, and it follows that salt required for curing or preserving fish should be relieved of all duty.

If trawling is found successful in the Bay, capitalists will no doubt step in, as has been the case in Cape Colony. The impetus thus given to deep sea fishing may also induce individual fishermen to work on their own account, but as steam-trawlers will be beyond their means, Government may show the way how to work sailing schooners to advantage by building a few and letting them out on hire, even subsidising or granting bounties, as in Canada, to such fishermen as exhibit commendable pluck and enterprise. There seems to be little doubt that a good type of schooners would also be very serviceable in the Sundarbans, especially in the distant estuaries of the Khulna district, which are at present mostly neglected, and the difficulty of transporting the catches would be greatly minimised by the use of small gasolene boats which would be independent of wind and tide.

No local material being available, it is inevitable that imported agency must be employed for the purpose of opening up the sea-fisheries, which will add materially to the working expenses. But it is to be hoped that in course of

time local fishermen will have sufficiently got over their prejudices and, have been sufficiently trained and educated to take their proper place in the work of developing this great industry and that not only all the appliances, including trawls, nets and lines, will be made, but also suitable vessels built in the country.

The Bengal coast is cut up by numerous broad estuaries, and they seem to be full of valuable food fish. But owing to the absence of good boats and quick transport many of them have not been touched at all, while a few are but imperfectly worked. With the development of the sea fisheries, estuarine fishing will also be stimulated. The improved type of vessels intended for sea-fishing will be equally useful in the estuaries, and during the worst period of the south west monsoon, when sea fishing may become difficult, all the boats could work in the estuaries. A smaller, simpler and cheaper style of boats may also be introduced for work in the estuaries and large rivers, and they could be easily fitted up with motor power. The introduction of gasolene-boats would go a long way to solve the question of rapid transport. There is great possibility of improving the supplies to Calcutta and other markets by more vigorous and systematic fishing in the estuaries.

The Shad in India.

The Indian shad, *clupea ilisha*, has a very extensive distribution on the East Coast where it is found in all the principal rivers falling into the Bay of Bengal. On the West Coast it appears only in the Indus in Sind and is practically unknown elsewhere. It begins its upward journey usually with the commencement of the freshets and continues moving up in shoals till about the close of the rains. In Madras it ascends the Cauvery from June to September, the Gadavery from July to the middle of October, and the Kistna from October till December. In Bengal it appears about the end of June, is most numerous from July to September and is met with till the end of October and sometimes even later.

It has various local names, viz., *hilsa* or *ilish* in Bengal, *sable* or *pallusa* in Madras and *palla* in Sind.

There can be no question that the shad is more abundant and the fishery more important in Bengal than anywhere else in India.

The shad in Bengal.

To the south of the Province it enters the Chilka apparently to work its way up the Daya and is fairly plentiful in the Daya, Mahanadi, Burabulong and Subarnarekha rivers, and in Orissa. In Lower Bengal proper it comes up the various mouths through which the Ganges debouches into the sea and is most plentiful in the Hooghly, Rupnarain, Baleswar and the Padma or main channel of the Ganges; where not obstructed by dams or anicuts it goes up long distances, large numbers being annually caught as high up as Patna (about 415 miles from the sea) and even higher. It ascends all the tributaries and branches of the Ganges, and there is scarcely a river in Bengal which does not receive its quota of the fish. The *hilsa* are caught in their thousands from the estuaries upwards, and some idea of the immensity of the shoals may be judged from the fact that though nets, traps and engines of all sizes and shapes are employed to capture them at short distances all along the route, a considerable number still manage to find their way many hundreds of miles from the sea.

In many of the rivers large quantities of *hilsa*, mostly immature, are caught in spring, and there is regular winter fishing in the Mādhumati and in the Hooghly near Kalna, as well as in many parts of the coast. In fact the capture of *hilsa* goes on throughout the year, not even the "spent" fish being spared. The fish are rich and of good flavour only during the spawning season, i.e., from July to October, but their destruction never ceases. In the course of our enquiries we received complaints from all directions that the supply of *hilsa* was greatly on the decline. On the one hand, owing to increase of population and improved transport there is a growing demand to meet which incessant fishing is resorted to throughout the year, and on the other, no steps are taken to protect the "spent" fish and fry in their downward run to the sea or to assist nature by artificial propagation. It is certain that if no remedial measures are adopted, in course of time the *hilsa* would at this rate be exterminated, or the fishery at least would greatly diminish, as was the case in the United States in 1879.

In this connection it is necessary to remember that in Bengal the religion of the Hindus prohibits the eating of *hilsa* from the last day of the Durga Puja (sometime in October) to the Sri-panchami day end of January or beginning of February), or in other words it enjoins a close season from about the

Ancient close season.

middle of October to the end of January, which very nearly corresponds to the period, when, according to the observations made in the United States, the fish ought to be descending to the sea after completing the act of spawning. But owing to general ignorance of the real meaning and purpose of the injunction it has become the practice to disregard it as one more piece of superstition, especially as all religious sanctions have lost much of their force. The only way of reintroducing the close season is by penalising the capture of *hilsa*, say, from the 1st November to the 15th February. No Hindu should object to this legislation, as it would only revive in another shape one of his sacred ordinances, and the facts stated above should convince the Hindu and the non-Hindu alike as to the necessity of affording temporary protection to the fish, the more so as it would involve no serious self-denial, the fish being of poor quality and hardly worth eating during this period.

During the last season, some attempt was made to get statistics of the *hilsa* fisheries in Bengal. Their presence is reported from all the divisions, and at a rough computation 8,000 boats are engaged in catching the fish. The boats are classified and named according to the kind of net used. The most favourite net is the *sanglia* which is a small wall net with an oval end secured by a piece of split bamboo to which a rope is attached. A *sanglia* boat carries three men and is moved up and down the river, and when a fish is felt in the net it is lifted, the bottom rope being pulled up at the same time so as to secure the fish in the fold. Only a few fish, generally one, is caught at each throw. A smaller form of this net is called *kharke*, and is managed by two men. The other nets in use are *bachhari* (large cast net), *khepla* (small cast net), *kona* (purse seine), *chhandi* (large seine), and *beuti* (small fixed purse net with a funnel end). *Bachhari*, *kona* and *chhandi* require large boats, two or more of which are used with one net, the number of men varying from 6 to 12. But they often make very large hauls. They are used in the large rivers. Of the total, *sanglia* boats number 4,000, *chhandi* 2,000, *kharke* 1,200, and *bachhari* and *kona* 400 each. The principal *hilsa* fishing takes place in the Presidency and Burdwan Divisions, *i.e.*, in the lower reaches of the rivers, where the fish naturally is more abundant and is of good flavour. During the height of the season the Hooghly on one side and the Padma on the other

swarm with *hilsa* boats of all kinds and attract fishermen from other parts of the country. As the *hilsa* continue their upward flight, they become scarcer and looser in quality. The fish caught in winter and spring are quite poor, and are usually of small size.

General.

The Indian shad and the American shad are different species of genus *clupea* of family *clupeidae*, and as regards size, shape, colour, weight, texture and quality of the flesh, etc., have much in common, though differing in many points of scientific nomenclature. They both ascend the rivers at certain seasons of the year and are caught in large numbers with roe. But while in America careful investigations have been made for many years and much knowledge has been acquired regarding the movements, food, spawning grounds and everything connected with the life history of the shad, in India the profoundest ignorance prevails on the subject, excepting, perhaps, a few obvious points that could not escape even a casual observer. As in France, the fishermen of Bengal believe that the *hilsa* does not spawn in the rivers, in proof of which it is asserted that no fry or young ones have ever been caught or seen. But after witnessing what the United States has achieved in locating the spawning grounds of the shad and in successfully undertaking artificial propagation, one must not rest content until systematic efforts have been made to see what can be done with the *hilsa* on those lines.

In the United States the period during which the shad may be caught is very short, seldom exceeding two months in the same river, and corresponds to the time of their ascent up the rivers in obedience to their spawning necessities. During the rest of the year, a strict close season is observed. For Bengal a much shorter close season is proposed, viz., from 1st November to 15th February. It may be extended hereafter to June, so as to stop the spring netting.

Very strenuous efforts must also be made to observe the reproductive functions of the *hilsa* and ascertain their spawning grounds, so that when their anadromous character has been established hatching stations may be opened to introduce artificial propagation for replenishing our rivers.

**INTERIM REPORTS OF THE MARINE FISHERY
INVESTIGATIONS OF THE GOVERNMENT
STEAM TRAWLER "GOLDEN CROWN".**

**I—REPORT ON THE WORKING OF THE STEAM TRAWLER
"GOLDEN CROWN" FROM JUNE TO SEPTEMBER 1908.**

**By MR. A. AHMAD, C.S., *Commissioner of Fisheries
Bengal.***

IN Mr. K. G. Gupta's final report on the enquiry into fisheries in Bengal, he urged the necessity of a regular fishing survey of the Bay under Government agency with a view to the opening up of a large supply of food material for the people of the country which has been hitherto overlooked and neglected. As a first step towards the opening up of sea fisheries, it was considered essential that Government should undertake a systematic survey of the Bay from the fishing point of view, so that the favourite haunts and the periodical migrations of fish may be ascertained and recorded and practical demonstration given as to what the sea is capable of yielding. As there would not be any immediate return from any such experiment and the initial outlay would be considerable, it was found necessary for Government to make the proposed survey. Mr. Gupta was anxious to have the proposed survey taken up at the commencement of the last cold season, and a definite proposal was submitted to Government in this office letter No. 570, dated the 31st October 1907, in advance of the publication of the final report.

For the proposal Cape Colony furnished a successful and appropriate precedent. There was no deep sea fishing worthy of the name there until Government bought a steam trawler and obtained the services of a suitable staff for the proper survey and investigation, with the result that now several steam trawlers owned by private parties are engaged in fishing. The proposal was approved and the Secretary of State was approached to sanction the scheme and to send out a suitable trawler with necessary appliances.

The trawler *Golden Crown* was bought by the Secretary of State and altered and fitted out to suit the climate and the requirements. The vessel was built in 1896 at Hull and

Description of the
survey vessel.

is of gross tonnage 183 and dimensions B. P. 110×21×11-⁴/₁₀ with draft loaded 13 feet 6 inches and speed 10 knots on 5 tons per diem with triple expansion engines by C. D. Holmes & Co., 60 H.-P. and with new steel multitubular boilers (December 1907). She was fitted up with large trawling winch capable of taking 1,000 fathoms. There was complete outfit of otter trawls, drift nets and long lines, and she was certified to be in first class condition throughout, having passed her No. 3 special survey with Lloyds and was inspected and approved by the Board of Trade. A considerable sum was spent on her by her late owners in fitting new decks and thoroughly overhauling her in every part. Everything was done by the Surveyor of Shipping to ventilate the quarters and to make the vessel suitable for tropical work. These additions and alterations took considerable time owing to which the vessel could not start before 19th February, when she sailed as bound on a two years' fishing voyage to and in the Bay of Bengal with the Secretary of State for India in Council as registered owner and under the charge of a permanent staff of five English crew and temporary staff whose engagement was only to reach her to Calcutta.

Immediately after her arrival in port I arranged an inspection of the vessel by the Deputy Director of the Royal Indian Marine assisted by the Naval Constructor on the morning of the 7th April. The Port Officer also kindly assisted me with advice and observation during the inspection. As the result of the inspection further improvements and alterations were found to be imperative, and on Government sanctioning the alterations, the work was taken up as urgent, and by the 10th of June the vessel was ready to sail.

On the 13th of June, with 20 tons of ice, with five European crew, one navigating officer and 17 Indian crew and two fishermen, the *Golden Crown* made her first trial trip, and on going out met the first onset of the monsoon at the mouth of the Bay, but in spite of this commenced trawling on the 15th June and proceeded to Balasore Roads, where she continued her operations at several places. From that time till the end of September she has made several cruises in the west coast to places from Pilot Ridge light-vessel to the south-west of Puri and in the east coast in the neighbourhood of Elephant Point and Eastern Channel light-vessel, with occasional

stoppages compelled by the necessity for petty repairs and other incidental difficulties. These stoppages, however, afforded welcome rest to the overworked crew, who had to be continually out during the worst monsoon months.

The actual operations during this period took place on 40 days, and the total catch amounted to about 12 tons in all. The quantity of the catches is very steadily increasing.

The vessel is in charge of a master skipper who is a well known trawling Captain from Hull. He is assisted by the trawling first hand (Mate), one drift net expert and a long line expert. Both these experts are at present helping the skipper in trawling operations. This will continue to be so until some other arrangements can be made to carry on experiments with drift nets and long lines. Besides these, a navigating officer with a Master Mariner certificate has to be retained for such a time as would enable the skipper to become familiarized with the Bay. The engine is under the charge of an experienced European Engineer. Besides, there is a complement of Indian crew, 17 in number, and two fishermen. One of the fishermen has shown such satisfactory progress that I took one fisherman apprentice sent by the Collector of Cuttack and two fishermen apprentices sent by the Raja of Kanika for training. The Cuttack man showing good aptitude has been taken in as a deck hand. I am endeavouring to make our fishermen take interest in the work of the trawler and I am glad to be able to say that so far my attempt has met with some success.

One of the important parts of the experiment is the safe bringing up of fish in good condition to Calcutta. In this respect the trawler has shown very satisfactory results. The fish hold and ice hold of the trawler seem to be all that are desired. The ice once loaded keeps well, there being very little wastage, and fish preserved in ice in the hold are brought to Calcutta in good condition without any deterioration in quality or appearance. On the average 15 tons of ice are being taken each trip. The ice is being supplied by two ice companies of Calcutta in equal shares at the cheap rate of Rs. 15 per ton.

The demand for a regular supply of sea fish is increasing gradually, and I have arranged through the Superintendent of the Sir Stuart

Carriage of fish
from the fishing
grounds.

Sale of fish.

Hogg Market to put a certain quantity of sea fish daily in the market according to demand from the Linde Cold Store where the entire stock is placed on arrival of the trawler in port. As the Linde Cold Store is situated at some considerable distance from the landing jetty and also from the market, a good deal of difficulty is being at present experienced in the transport of fish to and from the store. I am, however, giving my best attention to the satisfactory solution of the difficulties. The sale proceeds are increasing steadily. They have risen from Rs. 700 in August to Rs. 900 during September. It is believed that the sale of the trawler's fish has set free a large quantity of otherwise indifferent fish for the use of the masses, thus having been the means of lowering the price of ordinary kinds of fish which are the chief nitrogenous food available for the bulk of the people.

As a large quantity of indifferent fish and other sea fish, against which people still have some prejudice, is accumulating in the cold store, I have already arranged to open a small factory for the preparation of isinglass, fish oil and fish glue in consultation and co-operation with the Reporter on Economic Products under whose advice sanction has already been obtained for opening a drying house. I am also in communication with the Director of Agriculture for utilization of rejected fish for manure. I am hopeful to effect these arrangements shortly, thus being able to utilize the entire catch in the near future.

As one of the main objects of the fishery survey is to determine the haunts and migration of different species of fish found in the Bay, I am getting the representative species of each cruise identified by Mr. B. L. Chaudhuri, through the kind co-operation and guidance of the Superintendent of the Indian Museum, who very kindly supplies the vessel with two jars of Formalin Solution at each trip, and under whose guidance all the specimens collected are identified and preserved. I am glad to be able to say that already about 100 species have been identified, of which many are for the first time reported from the localities, and about six are believed to be new to science. Dr. N. Annandale has proposed to illustrate these fish lists with plates which he estimates will not cost more than Rs. 400. The proposal is now before the Government for sanction, on receipt of which the fish lists will be published with descriptions illustrated by plates.

I undertook certain enquiries to find out whether it would save time, expense and handling Miscellaneous. to stop the trawler at Diamond Harbour and Balasore and then bring up fish by train to Calcutta. So far as I have been able to ascertain, I find that the cost of carriage of ice and drinking water as well as the expense of loading and unloading at a distant port will far exceed the saving that may be otherwise effected. The trawler now takes full eight hours' run from Sandheads to port, and as ice is keeping on well, no difficulty is experienced in allowing her to come up to Calcutta.

II.—REPORT ON THE WORKING OF THE STEAM TRAWLER
 “GOLDEN CROWN” FOR THE QUARTER ENDING DECEMBER
 31ST, 1908.

BY J. TRAVIS JENKINS, D. SC., PH.D., *Fishery Adviser to
 the Government of Bengal.*

DURING the quarter under review the *Golden Crown* made seven voyages to the Bay of Bengal, viz.:—

- (1) From October 1st to 5th.
- (2) “ “ 11th to 14th
- (3) “ “ 22nd to 29th.
- (4) “ November 11th to 18th.
- (5) “ “ 21st to 1st December.
- (6) “ December 4th to 13th.
- (7) “ “ 17th to 22nd.

She also left for sea on December 30th, but as practically no fish were caught until midnight on the 31st, the result of this voyage has been kept for inclusion in the report of the first quarter for 1909. It may be mentioned here that between the third and fourth voyages (October 29th to November 11th) the *Golden Crown* went into dry dock for a few days for sundry repairs.

DETAILS OF JOURNEYS.

The items mentioned above include the whole of the journey from Prinsep's Ghat to the sea and back, so that at least one complete day must be allowed for the outward journey and a similar amount for the return voyage. For an average voyage, however, it would be well not to allow less than three whole days for the actual steaming to and from the fishing grounds, so that, although the trawler was actually away from Calcutta altogether 52 days during the quarter, the actual number of days engaged in trawling is somewhat less than this. In the case of a single vessel engaged in commercial trawling, it is immaterial whether in summarising results and comparing receipts with expenditure, one takes the number of days actually spent in trawling or the number of days the vessel is away from port as a basis for calculation of the amount of fish caught per day, since obviously expenses are accumulating even when the vessel is not actually fishing. In the case, however, of a small fleet of trawlers with a special vessel or vessels (carrier or cutter) engaged in conveying stores

outwards and fish homeward, the ratio of trawling days to journey days would naturally be higher than in the case of a single vessel; in order to facilitate comparison with such a fleet the trawling day has therefore been taken as the unit of time in the case of the *Golden Crown*. Where later in the report the amount of fish caught per day is referred to, it must be understood that the 'day' means a day actually engaged in fishing, exclusive of the time taken in travelling to and from the fishing grounds. The point is not an unimportant one, since, other things being equal, the longer the vessel is away from port the higher the average catch per day should be. In the case of a port with a long and difficult approach and heavy pilotage dues, it naturally would not pay to have one or two vessels making very short and frequent trips.

During the month of October the *Golden Crown* was engaged in fishing for 14 days, during November 10 days, and during December 11 days, making 35 days in all.

On the first trip (October 1st to 5th) trawling was tried off the Orissa coast between Konarak (Black Pagoda) and Puri in from 10 to 18 fathoms of water, the nature of the bottom varying from soft mud to sand and shells. From the 11th to 14th October she trawled between False Point and Konarak in depths of from 11 to 17 fathoms on muddy, sandy and shelly ground. From the 22nd to 29th October she again trawled off the Orissa coast between False Point and Konarak in from 9 to 15 fathoms on similar ground except that coral sand and stones were encountered.

On the fourth voyage (November 11 to 18th), after a preliminary unsuccessful trial off the Eastern Sundarbans, trawling was tried in the vicinity of South Patches light-vessel off the Arakan coast in depths of from 8 to 13 fathoms on a muddy and sandy bottom. Again from November 21st to December 1st, after a trial near the intermediate light-vessel, fishing was carried on off Konarak in from 14 to 21 fathoms. From December 4th to 13th, after a trial trip 26 miles from Pilot's Ridge light-vessel, the ground off the Orissa coast between Konarak and Puri was again visited. From the 18th to the 21st December fishing was tried near the Mutlah light-vessel.

It may be advisable to explain here that a steam-trawler engaged in fishing for commercial purposes trawls during the whole of the 24 hours, and this is precisely what occurs on the *Golden Crown*. All modern trawlers are fitted up with two full sets of gear in readiness for immediate use,

one on the port and one on the starboard side, so that, as soon as one net is hauled, the other may, if required, be shot. The *Golden Crown*, however, is unable to use her star-board gear and, as a consequence, frequent annoying, though unavoidable, delays occur. In surveying unknown grounds it is impossible at times to avoid serious damage to the nets, and all this damage must be repaired before the net can again be used. Hence, every time the net is torn on the *Golden Crown* she has to remain idle, while all hands turn to and effect the necessary repairs. This may at times cause serious delay and must be taken into account in estimating the weight of fish caught per day's trawling. The amount of delay, which would almost invariably be nil on a properly equipped vessel varies on the *Golden Crown* from nil to 25 per cent. of the time actually spent on the fishing grounds.

In addition, the impossibility of using the starboard gear on board the *Golden Crown* makes her handling at all times a more hazardous matter than it would otherwise be, and in comparing the *Golden Crown* catches with those of a moderately well-equipped vessel, this fact must not be omitted from consideration.

It does not appear that any absolutely fresh trawling ground was opened up during the quarter, and although the accumulation of evidence respecting the condition of each fishing ground in the Bay during each particular month of the year is undoubtedly of some service, still one or more voyages per quarter should be devoted in future to opening up absolutely new grounds, even though it will be necessary for this purpose to provide the vessel with additional, better and more varied gear than she at present possesses.

WEIGHT AND QUANTITY OF FISH CAUGHT,

The returns of weight per voyage are:—

				Weight. lbs.
First voyage	...	...	...	8,660
Second "	...	...	...	14,239
Third "	...	...	...	12,344
Fourth "	...	...	...	4,634
Fifth "	...	...	...	15,968
Sixth "	...	...	...	18,195
Seventh "	...	...	...	8,574
		Total	...	82,614

Thus the weight of fish caught during 35 days' trawling amounted to an average of 2,360 lbs. per day.

This excludes (except in one instance where their weight was included) turtles and all sawfish and sharks. If commercial trawling were attempted in the Bay, doubtless some use would be found for the livers and fins of these gigantic *Elasmobranches*. So far then as the actual quantity of fish caught per diem is concerned, the results are not unfavourable. Similar quantities in European waters, such as the North Sea, would render trawling a commercial success. In making this comparison it is, of course, necessary to make certain assumptions which may not turn out to be justifiable, and one of the most important of these is that the fish is of approximately equal edible value and commands a ready sale at similar prices to sea-fish in the markets of Northern Europe.

Some of these considerations need further investigation, and fortunately sufficiently reliable data exist for the comparison of the kinds of fish landed during each separate voyage, in some instances even for separate hauls of the trawl. This latter information, while doubtless of value for future work, whether of a scientific or commercial nature, is not analysed in the present report, and attention is solely directed to the quantities of each kind of fish landed per voyage. The question of sale and the many factors connected with it cannot be considered here. In England when strange sea-fish were first put on the market the public demand for them was practically nil. Many instances could be given of this; it will perhaps suffice to mention the Hake. This fish was formerly considered to be worthless, but the popular demand for it is now considerable, and it fetches a good price.

DETAILS OF THE "GOLDEN CROWN" CATCHES.

The detailed account of the *Golden Crown's* catches is given in the table below. The names of the fish are those given by the European crew of the trawler who, in some cases, have adopted local names (not always correctly), and in other cases have utilized the common names of European fish on account of some assumed external resemblance, or have even been driven to invent entirely new names for fish for which no local names were readily forthcoming and which had no resemblance to common European marine species.

The local names, or names already in use in India, adopted for the purposes of classification on the trawler, are Bektî, Bummaloh, Topsi and Pomfret. The Pomfret, as is well known, is a *stromateus* and two species are frequently caught in the trawler, namely, *cinereus* and *niger*. The former is the more abundant and in greater demand on account of its more attractive appearance. The Bummaloh (*Harpodon Nehereus*) is a *scopeloid* and is well known as the "Bômbay duck." The name Topsi is given to several species of *Polynemus*, including both *indicus* and *plebius*, although strictly speaking it should only be applied to *paradisus*. The Bektî of the *Golden Crown* is not the Bektî (lates calcarifer, of Bengal, but comprises two or more forms, notably the Datneh (*Chrysophrys datnia*) and a Pericoid form (*Pristipoma maculatum*.)

Of the names applied to fish in the Bay, which have been adopted on account of the presumed similarity to European species, the chief are whiting, herring, gurnards, halibut, conger, prawns, skate, soles, lobster and rock salmon. Of these the whiting, gurnard and rock salmon are structurally very dissimilar to those of European waters, and the names are based on a misconception of the nature of the Indian species. They are, however, sufficiently useful to be retained as market terms, though they should, strictly speaking, be always quoted in inverted commas. It would be difficult to replace them by any terms which would be understood by the public.

The Gadidae (cod, whiting, haddock, etc.) are not represented, and the so-called whiting of the *Golden Crown* include quite a number of very different forms, mostly species of *sciena*, *scienoids* and more rarely *unbrina*. The gurnards are siluroids of the genus *arius*, very largely *arius dussumeri*. As the siluroids are unknown in English markets, it is not surprising that these gurnards are absolutely unlike the English gurnards. The name is evidently given on account of the hard bony plates protecting the head which are found in both forms. It is strange that neither the whiting nor the gurnard finds a ready sale in the New Market, although both these fish, especially the former, are good eating. Possibly the rather numerous bones, and, in the case of whiting, the small size are prejudicial to a ready sale.

The rock salmon is entirely distinct from the true salmon. No member of the salmon family has been discovered in

Bengal waters, and the name "rock salmon" has been bestowed on *Otolithus Maculatus* on account of the spotted surface of the latter bearing resemblance to a salmon. This form and *Otolithus Ruber* are really scienoids.

The Halibut (*Psetodes erumei*) and the soles (species of *Cynoglossus* *synaptura* and *plaguria*), although differing from the British species similarly named, are nevertheless true flat fish (*Plueronectidæ*). The Conger eel is *murænesox cinereus*, the skates (large) mostly species of *Trygon* or string rays or (small) *mylobatis* and *ælobates*. The herring are Clupeoids, of the genera *Pellona* and *Chalæssus*. The prawns are principally *Percidæ* and *Palæmonidæ*, and the lobster is a *Panulerus* or spiny lobster, and in all these cases the names are sufficiently correct for commercial purposes. A few species of fish are grouped under the somewhat unintelligible headings of red flats, small flats, mixed flats and mixed. The red flats are *Pagrus spinifer*, a most excellent edible fish; the small flats vary considerably, usually they consist almost entirely of various species of house mackerel (*Caranx*), but sometimes *deepene punctata* and *ephippus orbis* predominate, and then the term mixed flats is sometimes employed, although there is no precision in the use of the terms. Under the heading of mixed fish we find very diverse forms; *saurena tumbil* is almost invariably present and mackerel (*Scomber Microlepedotes*) is also common.

TABLE SHOWING DETAILS OF CATCH PER VOYAGE.

(All weights expressed in lbs.)

Trip number...	1	2	3	4	5	6	7
Number of days fished.	5	4	5	4	6	7	4
Name of fish							
Whiting ...	2,150	3,710	4,900		3,108	4,502	2,749
Gurnards ...	1,450	1,540	1,555		2,688	4,568	1,688
Prawns ...	1,400	3,250	2,100		1,680	1,699	369
Rock Salmon ...	700	1,150	515		410	217	191
Herring and Flats.	700	300	590		...	...	...
Conger eels ...	500	954	490		40	904	464
Pomfrets ...	500	275	470		672	165	112
Bummaloes ...	450	350	315		...	...	...
Bekti ...	410	520	840		2,050	814	525
Skate ...	400	760	438		220	738	1,913
Soles ...	...	230	101		...	...	...
Turtles ...	...	1,200	...		(Five in No.)	...	(One in No.)
Halibut ...	...	...	...		60	122	112
Small Skates ...	...	...	...		...	...	51
Small Flats ...	...	...	...		1,680	2,811	291
Mixed ...	...	...	...		756	240	108
Red Flats ...	...	...	...		2,604	1,415	...
Total ...	8,660	11,239	12,344	4,634	15,968	18,195	8,574
GRAND TOTAL	...	...	...	...	...	...	82,614
	Orissa coast.	Orissa coast.	Orissa coast.	Arakan coast.	Orissa coast.	Orissa coast.	lbs. Matlah light-vessel.

It would be well to refrain from too minute a comparison of the different fishery grounds at the present juncture. No stress can be laid on the discrepancy between the result observed off the Arakan coast and the Orissa coast; all, one can say, is that with the gear at present on board the *Golden Crown* the latter coast is more profitable. With nets capable of being used on rocky ground (*i.e.*, with a bobbin foot rope) precisely the reverse statement might conceivably be made. The weight for the fourth trip is probably considerably under-estimated, even so the total weight for 35 days' fishing is, 82,614 lbs. or 2,360 lbs. per day. That is to say, in spite of the drawbacks under which the

Golden Crown has had to work, she has caught during the quarter well over a ton of fish per day's fishing. As explained above, with a trawler properly equipped, an increase of at least 25 per cent. could be expected.

It may not be amiss to remark here that the *Golden Crown* is a small and ancient type of trawler, and that her gear is by no means adequate for the work she has to perform, viz., the exploitation of the Bay. It is difficult to compare her catching power with a modern vessel with improved gear, but some appreciable percentage should be added to her catch if she be compared with a vessel of that type.

THE HANDLING AND MARKETING OF FISH.

When the catch is got aboard it is sorted, washed, weighed and then placed below in the ice-hold. When the vessel reaches Calcutta the fish is landed, some sent to the Linde Cold Storage, some to the Sir Stuart Hogg Market and some to Chingrighatta. It would be an easy matter to calculate from these figures the value of each separate landing from the *Golden Crown*, but as these prices are absolutely fixed it would serve no useful purpose to do so. Assuming the average catch per day's fishing of the *Golden Crown* to be not less than 2,400 lbs. then at the rate of 2d. per lb., the result of each day's fishing would be £20.

The figures given above of the weight caught per voyage need to be collected for a longer period, if only for the purpose of determining seasonal variations on different grounds.

CONCLUSION.

An appendix is attached with the names of the fish so far identified from the *Golden Crown's* catches. The list is provisional and incomplete and, in some cases, notably in the sciennoids, requires revision. So far as it goes, one learns that over 150 species of fish have been identified, and of these at least six are new to science.

APPENDIX.

List of fish captured by "Golden Crown" to December 31st, 1908.

This list must not be regarded as complete, but contains merely those identified at the time this report was written.

ELASMOBRANCHII—

Carchariidæ	...	{	Carcharias laticaudus.
			" sorrah.
			" menisorrah.
			" sp. nov.
			" temninckii.
			Zygæna blochii.
Scyllidæ	...	{	Stegostoma tigrinum.
			Urolophus griseum.
Pristidæ	...	{	Pristis annandalei (sp. nov.)
			" cuspidatus.
			" perrotteti.
			" zysron.
			" pectinatus.
Rhinobatidæ	...	{	Rhynchobatus djeddensis.
			Rhamphobatus ancylotomus.
			Rhinobatus granulosus.
Torpedinidæ	...	{	Narcine timlei.
			Gen. et. sp. nov.
			Astrape dipterygia.
Trygonidæ	...	{	Urogymnus asperrimus.
			Trygon gerrardi.
			" sephen.
			" imbricata.
			" zugei.
			" uarnak.
			" marginatus.
			" bleekeri.
			" walga.
			" microps.
			" favius.
			Pteroplatea micrura.
Myliobatidæ	...	{	" zonura.
			" tentaculata.
			Myliobatis nieuhoofii.
			" " var. nov.
			" maculata.
			Aetobatis narinari.
			" flagellum.

TELEOSTEI—

(1) *Physostomy*—

Muraenidae	...	Muraenesox cinereus.
Siluridae	...	{ Arius dussumieri. " thalassinus. " jella ?
Chirocentridae	...	Chirocentrus dorab.
		{ Pellona filigera. " indica. " brachysoma. Chatossus chacunda.
Olupeidae	...	{ " nasus. Engraulis taty. Dussumieria acuta. Opisthopterus tartoor. Raconda russelliana.
Scopelidae	...	{ Saurus myops. Saurida tumbil. Harpodon nehereus.
Scombresocidae	...	Exocoetus poecilopterus.

(2) *Acanthopterygii*—

		{ Serranus lanceolatus. Lutjanus annularis. " johnii. " malabaricus. Priacanthus holocentrum. Apogon quadrfasciatus. Therapon jarbua.
Percidae	...	{ " theraps. Pristipoma maculatum. " hasta. Synagris japonicus. " striatus. Gerres filamentosus. Pentaprion sp. Ambassis ranga.
Chaetodontidae	...	{ Scatophagus argus. Ephippus orbis. Drepane punctata.
Mullidae	...	{ Upeneoides vitatus. " sulphureus.
Sparidae	...	{ Pagrus spinifer. Chrysophrys datnia. " berda.

TELEOSTEI—continued.

(2) *Acanthopterygii*—continued.

		{	<i>Pterois russellii</i> .
		{	<i>Apistus carinatus</i> .
Scordænidæ	...	{	<i>Minous coccineus</i> .
		{	" <i>monodactylus</i> .
		{	<i>Sebastichthys strongia</i> .
Berycidæ	...	...	<i>Holocentrum rubrum</i> .
*Kurtidæ	...	...	<i>Kurtus indicus</i> .
		{	<i>Polynemus sextarius</i> .
Polynemidæ	...	{	" <i>indicus</i> .
		{	" <i>plebeius</i> .
		{	<i>Umbrina dussumieri</i> .
		{	<i>Sciæna diacanthus</i> .
Sciænidæ	...	{	" <i>ossea</i> .
		{	<i>Sciænoides brunneus</i> .
		{	<i>Otolithus maculatus</i> .
		{	" <i>ruber</i> .
		{	<i>Trichiurus muticus</i> .
Trichiuridæ	...	{	" <i>haumela</i> .
		{	" <i>savala</i> .
		{	<i>Caranx rottleri</i> .
		{	" <i>kurra</i> .
		{	" <i>guptæ</i> (sp. nov.)
		{	" <i>djedaba</i> .
		{	" <i>atropus</i> .
		{	" <i>armatus</i> .
		{	" <i>malabaricus</i> .
Carangidæ	...	{	" <i>gallus</i> .
		{	" <i>ciliaris</i> ?
		{	" sp. nov.
		{	<i>Seriola nigrofasciata</i> .
		{	<i>Chorinemus lysan</i> .
		{	" <i>moadetta</i> .
		{	<i>Equula edentula</i> .
		{	" <i>splendens</i> .
		{	" <i>insidiatrix</i> .
		{	" <i>ruconius</i> .
		{	<i>Stromateus cinereus</i> .
Stromateidæ	...	{	" <i>niger</i> .
		{	" <i>sinensis</i> .
Coryphænidæ	...	...	<i>Mene maculata</i> .
		{	<i>Scomber microlepidotus</i> .
		{	<i>Cybbium guttatum</i> .
Scombridæ	...	{	<i>Elacate nigra</i> .
		{	<i>Echeneis naucrates</i> .

TELLOSTHEI—concluded.

(2) *Acanthopterygii*—concluded.

Uranoscoopidæ	...	{ Uranoscopus cognatus. " guttatus. " crassiceps.
Trachinidæ	...	{ Sillago panijus. " sihama.
Pediunculati	...	Halicentæa stellata.
Cottidæ	...	{ Platycephalus scaber. " insidiatrix.
Cataphracti	...	Dactylopterus orientalis.
Callionymidæ	...	Callionymus longicaudatus.
Sphyrænidæ	...	Sphyræna sp.
Aulostomatidæ	...	Fistularia serrata.
Centrisoidæ	...	Amphisile scutata.
Pleuronectidæ	...	{ Psettodes erumei. Pseudorhombus arsius. Platophrys panthorina. Solea oculus. Synaptura commersoniana, " altipinnis. Plagusia marmorata. Cycloglossus puncticeps. " macrolepidotus. Rhomboidichthys valderostratus. " polylepis. " azureus.

(3) *Plectognathi*—

Sclerodermi	...	{ Triacanthus biaculeatus. " brevirostris. Ostracion nasus.
Gymnodontes	...	{ Tetrodon oblongus. " cutcutia. " nigropunctatus. " stellatus.

III.—REPORT ON THE WORKING OF THE GOVERNMENT STEAM TRAWLER "GOLDEN CROWN" FOR THE QUARTER ENDING 31ST MARCH 1909.

BY J. TRAVIS JENKINS, D. SC., PH. D., *Fishery Adviser to the Government of Bengal.*

DURING the quarter under review the *Golden Crown* made six voyages to the Bay of Bengal, this being one less than that of the previous quarter.

The dates of these voyages were:—

1. December 30th, 1908 to January 7th, 1909.
2. January 11th to 19th, 1909.
3. January 23rd to 29th, 1909.
4. February 9th to 15th, 1909.
5. February 19th to 27th, 1909.
6. March 5th to 15th, 1909.

Although the first voyage was commenced during the December quarter, fishing did not start until January, so the results are included here. The trawler also left for sea again on March 30th. At a meeting of the Fishery Board held on 19th March it was decided that the trawler should not go to sea until certain alterations had been made, and this is the reason why one trip less was made during the quarter.

DETAILS OF JOURNEYS.

To facilitate comparison with the previous quarter the above dates include the whole time the ship was away from port. The total number of days is thus 53, this being one more than the previous quarter. The average length of voyage is, however, $8\frac{5}{6}$ days, as compared with $7\frac{3}{7}$ for the previous quarter. This is an improvement, since, as will be seen later, with practically the same quantity of fish the expenses must be less, since one charge for pilotage dues has been saved as well as the coal bill for an extra journey.

Very probably if two longer journeys per month were made more fish would be caught, since the vessel would be longer on the fishing grounds and expenses would be lower. The actual number of days during which fishing operations were carried on was $31\frac{1}{4}$; during January $14\frac{3}{4}$, during February $8\frac{3}{4}$ and during March $7\frac{3}{4}$. This number is somewhat less—nearly four days—than for the previous quarter, although the trawler was one day more away from the port. This is partly due to the fact that longer voyages were made and more distant grounds visited, and also partly to

the damage done to the nets owing to the rockier nature of the ground trawled over, the necessary repairs causing frequent delays, since, as was explained in the previous report, the *Golden Crown* can only trawl with her port gear. •

The first voyage was to the Arakan coast, where trawling was tried in the neighbourhood of Elephant Point and subsequently off St. Martin's Reef and Oyster Isle (near Akyab). Then a course was set for the Orissa coast and fishing was tried off Konarak.

During the second voyage the ground trawled over was off the entrance to the Eastern Channel, in nearly 20 fathoms water, and the same ground was again trawled over during the 3rd and 4th voyages. On the 5th voyage trawling was tried first of all off Konarak and then off Gopalpur in 27 fathoms. After a few hauls at Gopalpur we steamed back to Puri and from there trawled back to Konarak. Later trawling was tried off the entrance to the Eastern Channel and down nearly as far as Mutlah lightship. The last voyage of the quarter was to the Orissa and Ganjam Coast. Trawling was tried off Konarak, Puri, Gopalpur, Sonapur, Rati, Pundi and Baruva, mainly in depths of from 20 to 30 fathoms.

WEIGHT OF FISH LANDED.

During this quarter all fish put below into the hold have been weighed. It is perhaps as well to emphasise here that sharks and sawfish are not included in the totals mentioned below :—

The total weight of edible fish was :—

1	...	...	...	4,262 lbs.
2	...	...	...	19,020 „
3	...	...	...	13,914 „
4	...	...	...	17,989 „
5	...	...	...	8,958 „
6	...	...	...	17,977 „
				<hr/>
				82,120 lbs., or 36½ tons approximately.

The details of these catches are submitted in an appendix.

During the quarter the average catch per day's absence from port of the *Golden Crown* was 13·80 cwts.; and the average duration of voyage 8·84 days.

For each day's fishing the quantity of fish caught was nearly 23 cwts.

CONCLUSION.

It has been found impossible to bring the list of species captured up to date. From the material already examined it is apparent that quite a number of species, not previously captured by the *Golden Crown*, have been obtained and several of these are marketable fish of excellent appearance and taste.

APPENDIX.

Statement showing the total weight of each kind of fish landed per voyage.

NAME OF FISH.	31st Decem- ber 1908 to 6th January 1909.	12th to 18th January 1909.	24th to 28th January 1909.	10th to 14th February 1909.	20th to 26th February 1909.	5th to 16th March 1909.	TOTAL.
1	2	3	4	5	6	7	8
	Mds.	Mds.	Mds.	Mds.	Mds.	Mds.	Mds.
Whittings ...	882	3,914	1,878	2,323	735	3,366	13,098
Gurnards ...	1,163	4,759	4,054	3,315	2,357	2,273	17,921
Bhekies ...	21	277	440	159	755	4,243	5,895
Prawns ...	59	314	80	350	389	941	2,133
Small flats ...	607	790	331	972	1,246	2,357	6,303
Red flats ...	77	...	...	...	319	1,007	1,403
Pomfrets ...	236	1,935	1,070	2,775	351	146	6,513
Conger eels ...	92	4,381	3,663	3,836	1,056	226	13,264
Halibuts ...	39	343	105	194	81	320	1,090
Skates ...	634	1,556	1,738	2,820	1,230	2,519	10,497
Turtles ...	...	6 in No.	...	...	...	80	80
Soles ...	45	491	228	178	64	59	975
Smelts ...	...	...	...	...	32	282	314
Mackerel ...	...	...	...	477	43	58	578
Rock salmon ...	84	256	327	403	56	...	1,126
Red perch ...	174	...	...	161	...	...	335
Mixed ...	149	89	...	...	...	...	288
Herring ...	...	...	...	26	...	...	26
Shark's fins ...	...	...	...	...	241	100	341
GRAND TOTAL ...	4,262	19,020	13,914	17,989	8,958	17,977	82,120

STATEMENT SHOWING THE WEIGHT OF FISH BROUGHT TO
SALE AND THE SALE-PROCEEDS FOR THE QUARTER END-
ING 31st MARCH 1909.

Months.		Weight of fish brought to sale.	Sale-proceeds of fish.		
		Mds. SRS.	Rs.	A.	P.
January 1909	...	227 26	974	9	3
February "	...	113 11	1,533	3	9
March "	...	182 22	545	13	3
Total	...	523 19	3,053	10	3

* Fish sent direct to Chingrighatta were not weighed. The weight given is the weight of fish stored at the Linde Cold Store and brought to the Hogg Market for sale.

A. AHMAD,

Commissioner of Fisheries, Bengal.

IV—REPORT ON THE WORKING OF THE GOVERNMENT STEAM
TRAWLER "GOLDEN CROWN" FOR THE QUARTER ENDING
30TH JUNE 1909.

By J. TRAVIS JENKINS, D. Sc., PH. D., *Fishery Adviser to
Government of Bengal.*

DURING the quarter under review the *Golden Crown* made two voyages to the Bay of Bengal. For the nine months ending 30th June, fifteen voyages were made, giving an average of five voyages per quarter, or $1\frac{2}{3}$ per month.

The dates of the voyages for the current quarter were:—

1. March 30th to April 7th.
2. April 15th to 25th.

Since 28th April the *Golden Crown* has been in dry dock for sundry repairs.

DETAILS OF JOURNEYS.

Both voyages made during this quarter were to the west side of the Bay. The first voyage was almost entirely devoted to trawling in the neighbourhood of Gopalpur: for the most part in depths of about 26 fathoms in coral ground. The second voyage, which was to some extent interfered with by heavy weather, was to the Orissa coast in depths of from 23 to 25 fathoms. Altogether the trawler was away from harbour on the first voyage nine days, and on the second eleven days; twenty days in all. On the first voyage there was five days' actual fishing, and on the second six and three-quarter days.

WEIGHT AND DESCRIPTION OF FISH LANDED.

The total weight of fish landed was:—

				lbs.
1st voyage	...	...	...	18,262
2nd "	...	...	...	25,736
		Total	...	<u>43,993</u>

In addition, two turtles were caught on the first trip and three on the second.

The details of the fish are as follows :—

			(Weight in lbs.)	
			1st trip.	2nd trip.
Whiting	...	...	3,695	3,612
Gurnards	...	...	2,821	5,585
Bektis	...	...	5,422	2,965
Red flats	...	...	749	...
Prawns	...	...	469	2,449
Small flats	...	...	1,827	1,636
Pomfrets	...	...	185	580
Conger eels	...	...	585	6,447
Halibut	...	...	281	171
Skate	...	...	1,946	1,748
Soles	...	...	139	294
Smelts	...	...	143	125
Mackerel	..	...	...	124
Total			18,262	25,736

In all 19 tons 12 cwts. 3 qrs. 10 lbs.

COMPARISON WITH PREVIOUS QUARTERS.

As regards the catch per voyage or catch per day's fishing, the present quarter shows a decided improvement and very possibly still better results may be obtained by going further south.

In all 19 tons 12 cwts. were caught as a result of $11\frac{3}{4}$ days' fishing. This gives an average daily catch of nearly 33·4 cwts., as compared with 23 cwts. for the previous quarter, and for each day's absence from port an average of 19·6 cwts, as against 13·8 for the previous quarter. The average duration of voyages was 10 days; for the quarter ending March 31st it was 8·84 days.

V—REPORT ON THE WORKING OF THE STEAM TRAWLER
GOLDEN CROWN FOR THE QUARTER ENDING SEPTEMBER
30, 1909.

By J. TRAVIS JENKINS, D. SC., PH. D., *Fishery Adviser to
the Government of Bengal.*

DURING the quarter under review the *Golden Crown* made two exploratory voyages to the Bay of Bengal, both during the month of September. The weather during the quarter has been most unfavourable, but in spite of this two successful voyages were made and encouraging results obtained.

On the first occasion the trawler left for sea on September 6th, returning to Calcutta on the 16th and the second trip commenced on the 20th, terminating on October 2nd. As fishing operations on the second trip ceased on the 30th September, this voyage is naturally included in this report.

DETAILS OF VOYAGES.

After the pilot left at 9-10 P. M. on the 6th the vessel was put on a course S. W. by W. On the 7th owing to the heavy swell the *Golden Crown* was put for some time on half speed. At 1 P. M. the first haul was made off Konarak and towing W. S. W. trawling was carried on till Puri light bore N. by E. This day's trawling was in depths of about 24 fathoms. On the 8th still heading S. W. the trawl was shot in 50 fathoms water, but the result was not so good as on the previous day. Subsequently trawling was tried in 26 fathoms. Rough ground was met with later in the day and the net was damaged.

On the 9th fishing was tried off Gopalpur in depths of from 24 to 30 fathoms, and the results achieved tend to show that this is the most suitable depth in these localities. On this day and the following (10th) fishing was carried on under very adverse and trying circumstances, there being strong winds with much rain and a heavy sea.

On the 11th trawling went on still off the Ganjam district of the Madras Presidency in very unfavourable weather with heavy squalls and much rain.

On the 12th trawling was tried between Gopalpur and Puri and off Puri the weather was again very bad.

On the 13th a heavy sea necessitated abandoning fishing operations from 2 to 11 A. M., after which fishing was tried 13 miles off the Black Pagoda Konarak. On the 14th the conditions were again against fishing, but it was nevertheless

persevered with. The 15th and 16th were occupied in the return journey.

On the second voyage the *Golden Crown* got under way early on the 20th, but owing to the heavy weather which prevailed she had to shelter in the river and the pilot did not leave until 1 p.m. on the 22nd. A course was set direct for Gopālpur and after a bad passage the trawl was shot off that place on the 23rd at 5-20 p.m. in 27 fathoms. A large saw-fish was caught in the first haul, which badly damaged the net. This fish measured exclusive of the saw 23 feet 6 inches in length. Subsequently the trawl was shot off Burma.

On the 24th, 25th, 26th, 27th, 28th and 29th trawling was carried on again under very trying conditions in various depths and at various localities off Barura and Sonapur. Again the best depths were found to be from 24 to 30 fathoms and, although the ground was very rough and the net frequently torn, good catches were made. From the 30th to the 2nd October the passage home was made.

Weight of fish caught (in lbs.).

Names.	1st voyage.	2nd voyage.
Bekti	3,259	4,130
Gurnards	7,338	2,810
Whiting	6,451	2,515
Prawns	6,105	1,920
Small flats	4,932	1,750
Congers	1,238	205
Red flats	540	1,144
Cod	571	268
Pomfret	259	45
Skate	845	430
Halibut	87	...
Mixed	...	55
Soles	35	...
Total	31,630	15,272

$31,630 + 15,272 = 46,932$

Four turtles were also caught on the first trip and one on the second. In spite of the very unfavourable weather that prevailed, over $418\frac{1}{2}$ cwts. of edible fish were captured, that is, very nearly 21 tons, an average of 10.5 tons per voyage.

Only a part of this catch was brought to Calcutta for sale, but this is not due to the fact that the fish cannot be brought up fresh. As a matter of fact, larger catches have been brought up in a perfectly fresh condition.

As the object of the *Golden Crown* is the location of the fishing grounds and not to prove that commercial trawling in the Bay can be made a financial success, it is unnecessary to enter into details here as to the price obtained for the fish placed on the Calcutta markets. It will suffice to say that the *Golden Crown* fish finds a ready sale at good prices.

For comparison with previous quarters, the amount caught per day's fishing has been calculated.

On the first voyage there were $7\frac{1}{2}$ days' actual fishing, and on the second voyage 6.

This gives an average of 31 cwts. per day's fishing, a result which is extremely creditable to Captain Mann and his European crew in view of the bad weather encountered and the fact that a large amount of time on each occasion was devoted to purely exploratory work.

The average catches per day's fishing of the *Golden Crown* may thus be summarised :—

Period from June to September 1908	...	6 cwts.
Quarter ending December 31st "	...	21 "
Ditto March 31st 1909	...	23 "
Ditto June 30th "	...	33·4 "
Ditto September 30th "	...	31 "

The progressive increase which was first noticeable in the quarter ending December 1908, has thus been well maintained and nowhere more marked than during the last two quarters when the weather has been most unfavourable for fishing.

For comparison with the above a statement is appended showing the average catch in cwts. per day's absence from port of first class English trawlers during 1907, that being the last year for which statistics are available :—

Region	Cwts. per day.	Region	Cwts. per day.
Iceland	... 41·16	Bay of Biscay	... 19·46
White Sea	... 43·14	West of Scotland	... 22·61
Rockall	... 41·18	North Sea	... 17·07
North of Scotland	... 37·90	British Channel	... 16·75
Faroe	... 34·35	Irish Sea	... 15·39
South of Ireland	... 26·92	English Channel	... 10·50
West of "	... 25·49	Portugal and Morocco	... 4·57

(*Vide* Annual Report of Proceedings under the Act relating to Sea Fisheries for the year 1907. Board of Agriculture and Fisheries, London, 1909.)

It is thus seen that the results obtained by the *Golden Crown* compare very favourably with first class steam

trawlers in England. In making this comparison, it must, however, be borne in mind that the figures given for the *Golden Crown* are cwts. per day's fishing, whereas those for English trawlers are per day's absence from port. On the other hand, many of the English vessels are much larger than the *Golden Crown* and they are fitted with more powerful gear and they are run on strictly commercial lines, whereas the object of the *Golden Crown* is exploration.

REPORT DATED THE 24TH DECEMBER 1909 ON
THE MARINE FISHERY INVESTIGATIONS
OF THE BENGAL GOVERNMENT STEAM
TRAWLER "GOLDEN CROWN," 1908-09.

By J. TRAVIS JENKINS, D. SC., PH. D., *Fishery Adviser to
the Government of Bengal.*

THE present report summarises the results obtained by the Bengal Government's trawler in the Bay of Bengal during the years 1908-09. Four interim reports have already been submitted to Government by the undersigned, viz.—

- (1) Report on the working of the *Golden Crown* for the quarter ending December 1908.
- (2) Report on the working of the *Golden Crown* for the quarter ending March 1909.
- (3) Report on the working of the *Golden Crown* for the quarter ending June 1909.
- (4) Report on the working of the *Golden Crown* for the quarter ending September 1909.

These reports, have already been published either wholly or in part in the *Calcutta Gazette* (*vide* Supplements for March 24th, June 16th, August 4th and October 13th, 1909).

Since September the trawler has made four voyages, and the results of these are included below. Necessarily much of this report is a recapitulation of previous ones.

INTRODUCTORY.

The results obtained by the *Golden Crown* naturally fall under two main headings, viz.—

- (1) Those of economic or commercial interest.
- (2) Those of scientific interest.

Under the former heading one might regard the vessel in the light of a commercial trawler, and one has to consider the possibility of trawling in the Bay from a financial standpoint since financial success is the only one in commercial undertakings.

• But since the *Golden Crown* has fished over grounds which have never been fished over with the trawl before and since large collections have been made not only of fish and edible crustacea, but of other animals as well, it follows that, when these collections have been reported on by specialists, much valuable information as to the distribution of marine organisms in the Bay of Bengal will have been accumulated. Not only will our knowledge of distribution have been increased, but additions to the Fauna of India will have been recorded. These two subdivisions of the *Golden Crown's* work are sharply separated from one another. Any undue prominence that might have been associated with one side of the investigation will naturally have affected the other.

Since all the facts with reference to the commercial side of the fishing operations are now at our disposal, deductions can be made as to the commercial value of the fishing grounds in the Bay and a comparison made with similar grounds elsewhere, so that a complete report on the economic aspects of the investigation can now be written.

With regard to the scientific side matters are somewhat different. The identification of each separate group of animals is a matter for specialists who almost invariably work the collections out in limited leisure hours. It is therefore hopeless to expect even a moderately complete account of the progress of zoological knowledge which has resulted from the *Golden Crown's* work for at least two years. Still an interim report of a tentative nature can be furnished even now, and one is appended couched so far as possible in non-technical language.

This report then falls into two parts—

- (1) A view of the commercial aspects of the undertaking.
- (2) An interim report on the scientific results.

The *Golden Crown* first started on a fishing voyage to the Bay of Bengal on 13th June 1908. Her last voyage terminated on 17th December 1909.

Between these dates she made 28 fishing voyages to the Bay; of these four were made solely to the east and 22 to the west side of the Bay. On two occasions both sides of the Bay were visited.

The dates of these voyages and the localities visited are summarized below:—

No. of voyage.	Date.	Locality.
1908.		
1	13th to 23rd June	... Pilot's Ridge and Balasore Roads.
2	6th to 13th July	... Near Elephant Point, Arakan Coast.
3	31st July to 5th August	... Off False Point, Orissa Coast.
4	19th to 22nd August	... Off Pilot's Ridge Light Vessel.
5	24th August to 3rd September	Arakan Coast.
6	13th to 29th September	... Arakan and Orissa Coasts.
7	24th to 27th September	... Orissa Coast.
8	1st to 5th October	... Orissa Coast between Konarak and Puri.
9	11th to 15th October	... Orissa Coast between False Point and Konarak.
10	22nd to 29th October	... Orissa Coast between False Point and Konarak.
11	11th to 18th November	... Arakan Coast.
12	21st November to 1st December	Orissa Coast off Konarak.
13	4th to 13th December	... Ditto between Konarak and Puri.
14	17th to 22nd December	... Near Mutlah light vessel.
15	30th December 1908 to 7th January 1909.	Arakan and Orissa Coasts.
1909.		
16	11th to 19th January	... } Off Eastern Channel, entrance to River Hooghly.
17	23rd to 29th January	
18	9th to 15th February	
19	19th to 27th February	... Orissa and Madras Coasts. Konarak to Gopalpur.
20	5th to 15th March	... Orissa and Madras Coasts down to Baruva.
21	30th March to 7th April	... Ganjam Coast.
22	15th to 24th April	... Orissa "
23	6th to 16th September	... Orissa and Ganjam Coasts.
24	20th September to 2nd October.	Mainly off Ganjam Coast.
25	13th to 25th October	... Ganjam Coast down to Oalingapatam.
26	10th to 18th November	... Arakan Coast.
27	24th November to 3rd December.	Off Konarak. Pilot's Ridge and Eastern Channel.
28	9th to 17th December	... Off Puri. Ganjam Coast and Eastern Channel.

A few details of the fishing during each voyage are appended.

First voyage, 13th to 23rd June 1908.—Trawling took place off the Pilot's Ridge light-vessel in 27 fathoms of water. Afterwards in Balasore Roads.

Second voyage, 6th to 13th July 1908.—Trawling first tried in Saugor Roads and then at intervals along a course from Pilot Ship to Elephant Point in depths of from 47 to 10 fathoms. Then off Elephant Point on sandy bottom in depths of from 13 to 23 fathoms, and also off the South Patches light vessel on mud and sand and shell from 8 to 21 fathoms.

Third voyage, 30th July to 5th August 1908.—“Trawling took place south of the mouth of the Devi river and beyond” (see Commissioner's report). But according to the bearings given in the log, the vessel fished always N. of Lat. 20° N., i.e., to the north of the mouth of the Devi river. i.e., off False Point and Point Palmyras. The depths trawled in were from 10 to 27 fathoms. The bottom varied. In most of the hauls it was mud, but occasionally sand and shell, and sand and mud were recorded.

Fourth voyage, 17th to 22nd August.—On this voyage fishing chiefly took place in the vicinity of Pilot's Ridge light-vessel in depths which varied from 16 to 30 fathoms. Muddy ground was, although met with, less prominent than in the previous voyage; the chief bottom being sand, and sand and mud. On this voyage there was a difficulty in working the engines which materially interfered with the fishing operations. The net sank in the mud and was only recovered with difficulty.

Fifth voyage, 24th August to 3rd September.—The first two hauls on this voyage were in 70 fathoms of water, the greatest depth at which the *Golden Crown* has attempted to fish. The bearings given are $20^{\circ} 34'$ N. and $89^{\circ} 44'$ E. and $20^{\circ} 36'$ N. and $89^{\circ} 47'$ E., respectively, i.e., to the east of the Swatch of No Ground. The results were not promising, so lesser depths were tried, first of all on a course for Elephant Point and then to the southward and westward of Elephant Point (Arakan Coast) in from 10 to 27 fathoms, the bottom being of green mud or dark sand.

There was again a difficulty in keeping up steam on this voyage and consequent interference with the fishing.

Sixth voyage, 12th to 19th September 1908.—In the first part of the voyage trawling was tried off the Arakan Coast

off Cox's Bazar and Elephant Point in depths of from 10 to 25 fathoms chiefly on muddy bottom. Subsequently trawling was tried off the Orissa Coast in depths of from 10 to 27 fathoms on muddy and sandy bottom.

Seventh voyage.—On this voyage trawling was tried on the 25th and 26th September in 15 and 16 fathoms water also off the Orissa Coast. Fishing was abandoned on the 26th on account of the illness of the mate and damage to the nets. Difficulty again this trip with regard to keeping steam up sufficiently for fishing purposes.

Eighth voyage.—Trawling was tried off the Orissa Coast between Konarak (Black Pagoda) and Puri in from 10 to 18 fathoms, the nature of the bottom varying from soft mud to sand and shells.

Ninth voyage, October 11th to 14th.—The *Golden Crown* trawled between False Point and Konarak in depths of from 11 to 17 fathoms on muddy, sandy, and shelly ground.

Tenth voyage, 22nd to 29th October.—Again off the Orissa Coast, between False Point and Konarak in from 9 to 15 fathoms on similar ground, except that "coral" sand and stones were encountered.

Eleventh voyage, November 11th to 18th.—After a preliminary unsuccessful trial off the Eastern Sunderbuns trawling was tried in the vicinity of the South Patches light-vessel off the Arakan Coast in depths of from 8 to 13 fathoms on a muddy and sandy bottom. The grounds near the ship are very free from debris, and the number of invertebrates caught in the trawl is inconsiderable.

Twelfth voyage, 21st November to 1st December.—After a trial near the Intermediate light ship, fishing was carried on off Konarak in from 14 to 21 fathoms.

Thirteenth voyage, 4th to 13th December.—After a trial 26 miles from Pilot's Ridge light-vessel the ground off the Orissa Coast between Konarak and Puri was again visited.

Fourteenth voyage, 17th to 22nd December.—Fishing was tried near the Mutlah light vessel, which bore from E. to W. N. W. The depths varied from 24 to 40 fathoms, except on one occasion when the net was shot in 14 fathoms. At this lesser depth very few fish were captured. The last haul was made on the course from Mutlah to the Eastern Channel. The ground near the Mutlah was invariably a soft mud.

Fifteenth voyage, 30th December 1908 to 7th January 1909.—On this occasion Captain Lloyd, member of the Fishery Board, was with us.

The first haul was made 150 miles E. by N. from Mutlah in from 13 to 18 fathoms, muddy bottom. Afterwards we trawled on towards the Arakah Coast in depths of from 12 to 20 fathoms, mud and sand. Trawling was tried 15 miles off Elephant Point which was then bearing E. N. E. and we worked gradually to the southward past St. Martin's Reef, which at the commencement of our second haul on 2nd January 1909 bore E. N. E. about 6 miles. During this haul we had a fine shelly ground in about 10 fathoms. The next haul resulted in the foot and head ropes being broken and the net was badly torn. As the starboard gear could not be used, there was a considerable delay (2 to 6.35 P.M.) while all hands were busy repairing the net. At 6 P.M. Oyster Island light showed up E. by S. $\frac{1}{2}$ S, the depth being 17 fathoms. The ground about here is rocky and the net was again torn next haul. Some of the finest fish were obtained here. Another trial was made on the 3rd, Akub then bearing E. N. E., but owing to the danger to the nets and the lack of spare nets on board (or in India) we had to abandon this most promising ground and set a course for Puri Coast. On 4th January shot net near Konarak in from 26 to 18 fathoms, and subsequently tried until net was completely torn up.

Sixteenth, seventeenth and eighteenth voyages—On these three voyages, from 11th January to 15th February 1909, fishing was confined to grounds southward of the Eastern Channel lightship on a muddy bottom in from 24 to 35 fathoms. The amount of time spent on this ground was excessive, and the enormous amount of time wasted here was solely due to the instructions given to the skipper to bring in fish for the Calcutta market.

Nineteenth voyage, 13th to 27th February 1909.—The first haul this voyage was made off the Orissa Coast near Konarak in 20 fathoms, the Black Pagoda bearing N. W. Next we tried off Gopalpur, this being the furthest south we had then been, in 27 fathoms, muddy bottom. Here the ground is thickly beset with Gorgonids and Sponges and Starfish are numerous. Good catches of fish were obtained, but owing to the roughness of the ground and our lack of nets we had to leave and try off Puri, which

we did in 20 fathoms, the White Pagoda then being N. by E. about 12 miles off. We then trawled along the coast to Konarak. On way back had hauls near Pilot Ridge vessel and between it and the Pilot ship. At the entrance to the Eastern Channel, near Pilot's Ridge, the depth of water was 28 fathoms, and in subsequent hauls 27 and 34. On the 25th at noon we shot near the Pilot ship in 22 fathoms and towed N. E. by E. We hauled in $21\frac{1}{2}$ fathoms mud about $1\frac{1}{2}$ miles off the Pilot ship which then bore N. by W. On the 26th we towed down till we were in sight of the Mutlah light vessel. The last two hauls were again near Eastern Channel, the light-vessel being about 9 miles off.

Twentieth voyage, 5th to 15th March.—The first haul was made 100 miles S. W. by W. from the Pilot ship in from 23 to 25 fathoms water. The second haul was in 27 fathoms soft mud off the entrance to Lake Chilka. On the 8th we fished off Gopalpur in 25 fathoms mud. After some hauls here we tried with Sonapur village abeam. Ground hereabouts thick with Gorgonids which damage the net, but fish are plentiful. On the 9th tried off Baruva in 23 fathoms and then subsequently off Rati Beacon and Pundi. Very good hauls of prime fish. This was as far south as we got. On the 10th we fished off Baruva and in the afternoon with a conspicuous tableland (Kuwita) abeam. Trawled repeatedly on way back chiefly in about 30 fathoms. On 12th and 13th tried again off Sonapur and Gopalpur in 23 to 25 fathoms. On the 14th fished off Ganjam and then finally off entrance to Lake Chilka. On 15th had a haul off Puri.

Twenty-first and twenty-second voyages—Were also off the Orissa and Ganjam Coasts, but no fresh ground was explored.

Twenty-third voyage.—After the pilot left at 9-10 P. M. on the 6th September, the vessel was put on a course S. W. by W. On the 7th owing to the heavy swell the *Golden Crown* was put for some time on half speed. At 1 P. M. the first haul was made off Konarak and towing W. S. W. trawling was carried on till Puri light bore N. by E. This day's trawling was in depths of about 24 fathoms. On the 8th still heading S. W. the trawl was shot in 50 fathoms water, but the result was not so good as on the previous day. Subsequently trawling was tried in 26

fathoms. Rough ground was met with later in the day and the net was damaged.

On the 9th fishing was tried off Gopalpur in depths of from 24 to 30 fathoms, and the results achieved tend to show that this is the most suitable depth in these localities. On this day and the following (10th) fishing was carried on under very adverse and trying circumstances, there being strong winds with much rain and a heavy sea.

On the 11th trawling went on still off the Ganjam district of the Madras Presidency in very unfavourable weather with heavy squalls and much rain.

On the 12th trawling was tried between Gopalpur and Puri and off Puri, weather again very bad.

On the 13th a heavy sea necessitated abandoning fishing operations from 2 to 11 A. M., after which fishing was tried 13 miles off the Black Pagoda (Konarak). On the 14th the conditions were again against fishing, but it was nevertheless persevered with. The 15th and 16th were occupied in the return journey.

On the *twenty-fourth voyage* the *Golden Crown* got under way early on the 20th, but owing to the heavy weather which prevailed she had to shelter in the river and the pilot did not leave until 1 P. M. on the 22nd. A course was set direct for Gopalpur, and after a bad passage the trawl was shot off that place on the 23rd at 5-20 P. M. in 27 fathoms. A large saw-fish was caught in the first haul, which badly damaged the net. This fish measured exclusive of the saw 23 feet 6 inches in length. Subsequently the trawl was shot off Baruva.

On the 24th, 25th, 26th, 27th, 28th, and 29th trawling was carried on, again under very trying conditions, in various depths and at various localities off Baruva and Sonapur. Again the best depths were found to be from 24 to 30 fathoms and, although the ground is very rough and the net frequently torn, good catches were made. From the 30th to the 2nd October the passage home was made.

During the *twenty-fifth voyage* the *Golden Crown* went further south on the west side of the Bay than she did either before or since. She left Calcutta on the 13th October and after a preliminary haul off Konarak to test the gear after the rough work of the preceding voyage, trawling was tried on the 15th off Pundi in 25 fathoms, and from there the vessel trawled down past Calingapatam and Santapilli in varying depths. Experience shows that here again the best fishing

grounds are in depths of from 23 to 28 fathoms. Trawling was carried on in this vicinity until the 21st October when she commenced to trawl on her return voyage past Earuva, Gopalpur, Puri and Konarak. On the 25th October the *Golden Crown* reached Calcutta.

The *twenty-sixth voyage* was to the Arakan Coast. Calcutta was left on 10th November and on the 12th the trawl was shot in 20 fathoms off Akyab, the weather being then very threatening. Trawling was carried on unsuccessfully on the 13th; early on the 14th a cyclonic storm was encountered, which lasted well into the 15th. The vessel having shipped a lot of water and provisions being spoilt, a course was set for Calcutta which was reached on 18th November.

The *twenty-seventh voyage*.—Left Calcutta 24th November. During this trip the *Golden Crown* trawled off the entrance to the Eastern Channel, on Pilot's Ridge, off the Devi river, off Konarak and then again off the Eastern Channel. The ship returned to Calcutta on the 3rd December.

The *twenty-eighth voyage*.—Left Calcutta 9th December. The course was first of all set for Puri and trawling was tried there and subsequently off Gopalpur in slightly greater depths than hitherto, from 30 to 38 fathoms. On the evening of the 13th the vessel left the Gopalpur grounds, and on the evening of the 14th trawling was tried off the entrance to the Eastern Channel. At 5-30 p. m. on 16th December the net was hauled for the last time, and on Friday, the 17th December, the *Golden Crown* arrived in the Hooghly off Prinsep's Ghât.

STATISTICAL TABLE AND REMARKS THEREON.

As the first few (seven) voyages of the *Golden Crown* were of a pioneer nature, only the details of the fish caught between 1st October 1908 and 17th December 1909 are here appended, and the results of the first seven voyages are not considered either in the statistical table or review.

Details of fish caught by the "Golden Crown" from 1st October 1908 to end of December 1909.

[All weights are expressed in pounds.]

		VOYAGE NUMBER—																				Total.						
		8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28						
Day's actual fishing.		5	4	5	4	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
KIND OF FISH.		5	4	5	4	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Whiting	2,150	3,710	4,900	800	3,108	1,502	2,749	882	3,011	1,877	3,253	775	886	2,257	3,005	3,618	6,451	9,515	1,705	5,690	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750
Guaruda	1,450	1,510	1,555	600	3,088	1,568	1,688	1,103	4,779	4,054	3,315	1,877	2,257	2,257	2,257	2,257	2,257	2,257	2,257	2,257	2,257	2,257	2,257	2,257	2,257	2,257	2,257	2,257
Pravus	1,400	3,250	2,100	1,650	1,669	800	29	59	314	40	330	889	941	4,300	1,690	2,149	6,105	1,930	3,110	4,580	2,740	2,740	2,740	2,740	2,740	2,740	2,740	2,740
Rock salmon	700	1,150	515	1,020	1,410	217	101	84	253	227	4,300	889	941	4,300	1,690	2,149	6,105	1,930	3,110	4,580	2,740	2,740	2,740	2,740	2,740	2,740	2,740	2,740
Small flats	700	500	580	1,850	931	203	62	138	303	303	3,285	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206
Concave fish	500	954	400	1,150	1,410	203	62	138	303	303	3,285	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206
Pomfrets	500	954	400	1,150	1,410	203	62	138	303	303	3,285	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206
Bunnaloos	400	350	315	111	672	103	112	28	1,383	1,070	1,775	351	140	2,377	1,827	1,698	4,232	1,750	5,100	1,450	1,450	1,450	1,450	1,450	1,450	1,450	1,450	1,450
Reku	410	520	840	575	2,620	854	256	21	277	430	1,700	753	430	1,700	753	430	1,700	753	430	1,700	753	430	1,700	753	430	1,700	753	430
Skate	400	700	458	247	220	735	1,060	654	1,506	1,778	2,800	1,506	1,506	1,506	1,506	1,506	1,506	1,506	1,506	1,506	1,506	1,506	1,506	1,506	1,506	1,506	1,506	1,506
Shales	400	230	101	28	66	122	712	112	1,380	1,165	1,165	1,165	1,165	1,165	1,165	1,165	1,165	1,165	1,165	1,165	1,165	1,165	1,165	1,165	1,165	1,165	1,165	1,165
Halibut	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Red perch	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Red flax	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cod	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Mixed	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Shark's fins	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Turtles	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Total	8,660	14,239	12,344	4,731	15,408	18,125	8,574	4,292	19,029	13,914	17,981	8,588	17,977	18,222	18,222	18,222	18,222	18,222	18,222	18,222	18,222	18,222	18,222	18,222	18,222	18,222	18,222	18,222

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SUMMARY OF RESULTS.

It is necessary to consider the attributes of successful trawling and to judge the *Golden Crown* in the light of these. As the conditions—suitability of fish to popular taste, market price and other factors—vary materially in Great Britain and in India, the comparison should not be pushed too far.

In any comparison which might be made between the results obtained by the *Golden Crown* and those of steam trawlers fishing on commercial lines in European waters, many assumptions have to be made some of which may turn out to be not quite justifiable. Still there remain sufficient data to enable one to make with confidence certain statements as to the value of the work undertaken by the Bengal Government.

(1) In the first place it has been proved that there are large areas in the Bay in which trawling is possible. These potential fishing grounds, at any rate, as regards trawling (excluding for the moment other methods of fishing) are found practically everywhere in the Bay of Bengal between the ten and hundred fathom lines. The best grounds located by the *Golden Crown* were those between the 25 and 35 fathom lines on the west side of the Bay between Konarak and Santapilli (Madras Presidency).

Instances may be quoted to prove that in certain localities at certain seasons of the year fish are to be found in very large quantities. Critics may argue that instances to prove the exact converse of this might also be quoted, but in a commercial undertaking one is not so much concerned with the fact that there are localities which are not good fishing grounds as that some localities undoubtedly are sufficiently prolific to enable commercial trawling to be successful, provided other factors—such as accessibility to a market—are also present. The poverty of some localities in the Bay is an interesting fact from a scientific point of view, but from a commercial standpoint it may be ignored provided sufficient instances of other localities better provided with fish can be quoted.

A few instances of the quantities and kinds of fish caught in a *single haul* of the trawl are given, viz.—

On 16th October 1909, at 5-30 P.M., the trawl when hauled was found to contain 835 lbs. weight of bektis (various Percoid forms, of excellent taste and certainly to be

classified as prime fish), 530 lbs. of small flats (*Carangidae* and *Squamipinnes*), 450 lbs. of whiting, 400 lbs. of gurnards, 240 of prawns and 8 of pomfrets. The total weight being 2,463 lbs., or approximately 1 ton 2 cwts. (nearly 31 maunds). This haul was made Santapilli light bearing W. N. W., 16 miles off the depth being 28 fathoms.

Again on 22nd October 1909, at noon, the result was 700 lbs. of small flats, 600 whiting, 390 prawns, 260 gurnards, 175 pomfrets, 75 bektis and 20 skates. The total weight was 2,220 lbs., or just under 1 ton. Locality: Puri Pagoda bearing N. E. 15 miles off. Depth 16 fathoms.

On 29th September 1909, the total catch at 5 P. M. amounted to 2,255 lbs. (over a ton), made up as follows: Gurnards 650, whiting 460, small flats 275, bektis 320, prawns 260, red flats 70, skate 60, cod 30, conger 10 and mixed 210.

Locality: Gopalpur bearing N. W. depth 25 fathoms.

• It is of course fair criticism to argue that unless it can be shown that the average weight of fish caught per hour's or per day's fishing is sufficiently high to compare with similar modes of fishing elsewhere, it is of little use quoting figures like the above.

Consequently it is necessary to compare the average catches of the *Golden Crown* for a fairly extensive period with those of similar trawlers in other waters, and the weight of fish in cwts. per day's trawling is taken as the basis of comparison.

The results of the *Golden Crown's* work are—

	Cwts. per day.
For the period from June to September 1908...	6
Quarter ending December 1908 ...	21
„ „ March 1909 ...	23
„ „ June 1909 ...	33 4
„ „ September 1909 ...	31
„ „ December 1909 ...	25

The detailed figures upon which the above statements are based have already been furnished, except for the quarter ending 31st December 1909. They may be confirmed by reference to the table on page 55 of this publication.

The basis of the December quarter (1909) calculation, is given—

No. of voyage.	No. of days fishing.	Weight of fish caught. lbs.
25	8.5	24,473
26	Nil	Nil
27	7	19,980
28	4.5	11,488
Total	20	55,941

Average catch in cwt. per day's fishing 25 (nearly).

It may be argued that some deduction should be made on account of the 26th voyage during which the trawler met with a cyclonic storm off the Arakan Coast, which prevented any fishing taking place. The diminution of the average for the whole period by $\frac{1}{8}$ th, or 3.57 per cent. (since one voyage out of 28 was unproductive) will not, however, materially affect the results, but naturally the prospect of an occasional barren voyage must be kept in view by any company which might be formed to fish the Bay commercially.

If a complete year is taken for comparison with results obtained elsewhere, then the year 1909 should be selected, since in 1908 the work was of a much more exploratory nature, and in addition the operations were commenced at the most unfavourable season of the year, just at the break of south-west monsoon; so that only part of the year was utilized for trawling.

Taking then the year 1909, we find the following result is obtained:—

	Weight of fish caught in lbs.	Number of days fishing.
First quarter 1909	82,120	31 $\frac{1}{4}$
Second " "	43,998	11 $\frac{3}{4}$
Third " "	46,932	13 $\frac{1}{2}$
Fourth " "	55,941	20
Total	227,991	76 $\frac{1}{2}$

This gives an average for the whole year of 26.6 cwt. per day's trawling.

As this calculation is based on a complete year's work, minor fluctuations are, as far as possible, avoided.

For comparison with the above a statement is appended showing the average catch in cwts. per day's absence from port of first class English trawlers during 1907, that being the last year for which statistics are available:—

Region.	Cwts. per
Iceland	41.16
White Sea	43.14
Rockall	41.18
North of Scotland	37.90
Faroe	34.35
South of Ireland	26.92
West of Ireland	25.49
Bay of Biscay	19.46
West of Scotland	22.61
North Sea	17.07
British Channel	16.75
Irish Sea	15.39
English Channel	10.60
Portugal and Morocco	4.97

(*Vide* Annual Report of Proceedings under Act relating to Sea Fisheries for the year 1907. Board of Agriculture and Fisheries, London, 1909.)

It is thus seen that the results obtained by the *Golden Crown* compare very favourably with first class steam trawlers in England. In making this comparison, it must however be borne in mind that the figures given for the *Golden Crown* are cwts. per day's fishing, whereas those for English trawlers are per day's absence from port. On the other hand, many of the English vessels are much larger than the *Golden Crown*, and they are fitted with more powerful gear and they are run on strictly commercial lines.

Or the comparison may be made in a different manner. The *Golden Crown* made fourteen voyages during 1909, from one of which no fish was landed. During the year 227,991lbs. weight of fish were caught, this giving an average of 145.4 cwts. per voyage including the unsuccessful trip.

The duration of the voyages was—

	Days.
First quarter	53
Second „	20
Third „	23
Fourth „	38½
Total	134½

This gives an average duration of voyage of 9·6 days. Calculations of this kind have been made for the trawlers of the port of Aberdeen by Dr. Fullerton (see "Fish Trades Gazette," 18th August 1906: "The Fishery Problem of the North Sea") and these calculations and results may be compared with those of the *Golden Crown*:—

	Year.	Average duration of voyage.	Average landing in cwt.
Port of Aberdeen	... 1903	6·8	127·4
Ditto	... 1902	7·1	123·5
Ditto	... 1901	6·7	118·2
<i>Golden Crown</i>	... 1909	9·6	145·4

This comparison is by no means unfavourable to the *Golden Crown* since the greater average length of voyage is not due to a greater amount of time devoted to fishing but to the fact that Calcutta, unlike Aberdeen, is situated at a considerable distance from the open sea.

If one compares the latest figures available for Aberdeen, namely, 1903, it is seen that on the average the *Golden Crown* was nearly three days longer away from port each voyage. This time may quite reasonably be allowed for the journey up and down the river so the conclusion arrived at is that the *Golden Crown* (in 1909) caught on the average more fish than the trawlers of the Port of Aberdeen in 1903, although the time devoted to actual fishing cannot have been far from identical in the two cases.

Broadly speaking the *Golden Crown* has trawled over four more or less distinct areas. These are—

- (1) An area commencing near the Mutlah light-vessel and extending down past the entrance to the Eastern Channel and so to the Pilot's Ridge.
- (2) Off the Arakan Coast from the South Patches light-vessel (entrance to the channel leading to Chittagong) to Oyster Island in the vicinity of Akyab.
- (3) The coast of Orissa from the mouth of Devi river to the entrance to Lake Chilka.
- (4) The coast of the Ganjam district of Madras Presidency from Ganjam to Santapilli light-house (in Vizagapatam district).

A few hauls only were made off the coast of the district of Vizagapatam.

A comparison of the yield of these grounds is hereby given, and an attempt is made in the scientific part

of the report to picture the fauna of each area. Of the four areas the one least explored is that off the Arakan Coast and this is partly due to two circumstances:—

- (1) Its distance from Calcutta.
- (2) The fact that the nets of the *Golden Crown* were hardly suitable for the more rocky grounds of this area.

Area I.—Mutlah Light Vessel to Pilot's Ridge.

Voyage No.	Month of—	Weight of fish in lbs.	Days fishing.
14	December 1908	... 8,574	4
16	January 1909	... 19,020	6.5
17	" "	... 13,914	4.75
18	February "	... 17,989	5
19 (part)	" "	... 4,531	1.25
27 (")	November "	... 13,765	5.25
28 (")	December "	... 8,511	1.75
Total		... 86,304	28.5

The average weight per day's fishing on this ground is therefore 27 cwts. Although here the maximum quantity of fish caught per day's fishing was recorded, the fish was of inferior quality to that from the other areas and consisted mainly of enormous "skates," "congers," "gurnards," (catfish) and small specimens of other species.

Area II.—Arakan Coast between South Patches Light Ship and Akyab.

Voyage No.	Month.	Weight of fish in lbs.	Days fishing.
11	November 1908	... 4,634	4
15 (part)	December "	... 3,222	2.75
26	November 1909	... Nil	Nil
Total		... 7,856	6.75

Average weight per day's fishing 10.4 cwts. In the southern part of this area prime fish (sea perches) are taken, but this district has not been so fully explored as the others, and consequently less can be said about it.

Area III.—Orissa Coast from the mouth of Devi River to entrance to Lake Chilka.

Voyage No.	Month.	Weight of fish in lbs.	Days fishing.
8	October 1908	... 8,660	5
10	" "	... 14,239	4
12	November "	... 12,344	5
13	December "	... 15,968	6
15 (part)	January 1909	... 18,195	7
19 (")	February "	... 1,040	0 75
20 (")	March "	... 3,704	2
22	April "	... 3,545	1 25
23 (half)	September "	... 25,736	6 75
25 (part)	October "	... 15,830	3 75
27 (")	November "	... 3,385	0 5
28 (")	December "	... 6,215	1 75
		... 885	0 25
	Total	... 129,746	44

Average weight per day's fishing 26·3 cwt.

Here the percentage of prime fish is high. The most characteristic fish is probably the "red flat" (*pagrus spinifer*).

As regards the quality of fish caught, this region stands between I and IV (as it does geographically). So far as one can make such a generalised statement with confidence, the further south one goes the better fish one meets with.

Area IV.—Off the Ganjam Coast of Madras Presidency from Ganjam to Santapali (Northern Circars Coast).

Voyage No.	Month.	Weight of fish in lbs.	Days fishing.
19 (part)	February 1909	... 723	0 5
20 (")	March "	... 14,432	6 5
21	April "	... 18,462	5
23 (half)	September "	... 15,830	3 75
24	" "	... 15,272	6
25	October "	... 21,683	8
28 (part)	December "	... 2,092	2 5
	Total	... 87,699	32 25

Average weight per day's trawling 24·3 cwt.

In this area the proportion of prime fish is the greatest. The sea perch predominate here and the coarse fish are relatively less numerous here than in the other areas.

• (2) Secondly, it has been proved, that trawling is possible in the Bay at all seasons of the year. A reference to the log of the *Golden Crown* shows that she trawled during every month of the year, except May, but this exception was rather due to the fact that she was undergoing repairs during that month than that trawling was then impossible. The *Golden Crown* worked right through the monsoon of 1908, and during 1909 she fished through September, October and November, when exceptional weather for the time of year was encountered and only one voyage out of 28 was spoilt through unfavourable climatic conditions. With the larger and more powerful vessels which are at present being built, it should be possible to fish in the Bay with less loss of time and delay through bad weather than is the case in European waters, where, as is well known, gales occasionally put a stop to all kinds of fishing.

(3) It has been proved that sea fish can be landed in a fresh condition in Calcutta from places as distant as Akyab and Santa-palli. The fish when caught are washed in clean sea water, and then with the exception of the soles which are gutted) placed in the hold in ice in an ungutted condition. In this way it will keep fresh for an indefinite period.

(4) The fish in the Bay are to a large extent of excellent appearance and taste, and should command a ready sale in Calcutta and upcountry markets. Naturally all the fish are not of the same attractiveness, but the coarser varieties can be disposed of to the poorer classes. I have no hesitation in saying from personal experience that some of the larger percoid forms obtained from off the Ganjam Coast, the so-called "bektis" of the *Golden Crown*, will compare favourably with the highest class of European sea fish such as the turbot, and if they could be placed on the European markets would fetch similar prices to the "prime" fish of English markets.

It is self-evident that much better prices would be obtained by a company controlling a fleet of trawlers than was possible in the case of an isolated vessel like the *Golden Crown*. The prices at which the *Golden Crown* fish was sold were given in a previous report for 31st December 1908, No. (1) above.

In concluding the first part of this report, I feel that I should be failing in my duty if I did not draw the

attention of Government to the energy and ability with which Mr. Geo. Mann, the master of the trawler, has discharged his duties during the two years under review. I have accordingly much pleasure in doing this.

PART II.—THE SCIENTIFIC INVESTIGATIONS.

As a rule the *Golden Crown* made four hauls a day—at daybreak, at noon, just before sunset and at midnight. For the last haul the acetylene gas installation on board was used, but even so the sorting of specimens was attended with some difficulty. The largeness and frequency of the hauls made it practically impossible for any work to be done on board except the collection of typical specimens and the noting of the localities from which they were obtained.

On arrival at Calcutta the collections were transferred to the museum where they were arranged into groups, so that each separate group might be sent to a specialist for report. The work of classifying and identifying these collections is now in active progress. Some groups, notably the rays and saw-fish (*Batoidei*), have been nearly completed, on other groups work has hardly been started. When these reports are completed, we shall be able to describe accurately the fauna of the various fishing grounds in the northern part of the Bay of Bengal which have been trawled over by the *Golden Crown*. Not only the fish but various groups of invertebrates, such as the crustacea, molluscs and echinoderms may prove of economic importance. As pointed out in the first part of this report there are four more or less distinct areas which have been investigated by the *Golden Crown*. An attempt is made to describe briefly the nature of the fauna in each of these areas.

AREA I.—THE FISHING GROUNDS.

Around the Mutlah light vessel and right away to the westward of it, past the entrance to the Eastern Channel down to the vicinity of the Pilot's Ridge the bottom of the sea consists of an extremely fine and soft mud. On these grounds in order to trawl successfully the vessel has to be kept going at a fairly good speed since otherwise the net would become embedded in mud. The mud itself is of

course derived from the deposit of particles brought down by the rivers of the Gangetic delta. A very large number of the empty shells of a species of *Dentalium* (a *Scaphopodous* mollusc) is met with here. Peculiar round balls of mud are brought up occasionally in the trawl and these when opened are found to have a species of mussel (alive) inside. Generally speaking, on these muddy grounds, the invertebrate fauna is scanty, and the vertebrate fauna (fish) is quite distinctive and in marked contrast to any of the other areas. Many fish and invertebrates are ubiquitous in the Bay, but in spite of these each separate area is distinctly marked off from its neighbour.

The fish fauna may be considered under two separate headings, namely, the cartilaginous fish (*Chondropterygii*) and the bony species (*Teleostei*).

Of the former there are two sub-orders, namely, the sharks and the skates and rays.

The sharks (*Selachioidei*) are for the most part surface swimming forms, and are only occasionally caught in the trawl. *Carcharias manisorrah* seems to be the commonest form here, but possibly *Chiloscyllium indicum* may be so. The hammer-headed shark (*Zygæna*) is taken here, but very rarely.

The Batoidei* are well known. This group includes skates, rays and saw-fish.

The saw-fish (*Pristidae*) do not appear to be more characteristic of one area than another.

Of the skates and rays *Trygon uarnak* and *Trygon bleekeri* are very characteristic of the muddy area, especially the former. Many females of *Trygon uarnak* were captured in a pregnant condition. The young when born is much unlike the parent in the markings on the dorsal surface of the body and in the prominence of the eyes which are almost pedunculate. On one voyage (No. 14) to the vicinity of the Mutlah light vessel nearly one-fourth by weight of the catch consisted of *Trygon uarnak*. In one haul (20th December 1908), at 11 P. M., four individuals were captured, which weighed respectively 180, 170, 160 and 122 lbs.

The most abundant Teleostean of this region is the so-called "gurnard" of the *Golden Crown*, which is

* See Memoirs of the Indian Museum, Vol. II, No. 1. Report on the Batoidei of the *Golden Crown* by N. Annandale. D. Sc.

really a cat-fish (*Siluroid*) of the genus *Arius*. This genus is estuarine in its habits, and in all probability it breeds in the Sunderbans. Occasionally hauls were made on this ground in which the catch consisted almost entirely of these fish and another Teleostean, the so-called "conger" (*Muraenesox cinereus*). The biggest hauls of pomfrets were also made on this ground though there is no reason to think that this fish is more characteristic of this than of any other area.

The commonest sole of the Bay (*Cynoglossus macrolepi dotus*) is also more abundant here than elsewhere, and the same may be said of the Bammaloh or Bombay duck (*Harpoön nehereus*) a true estuarine form, the young of which are found all over the Sunderbans in brackish water.

The solitary Indian Gadoid (*Bregmaceros maclellandi*) was twice recorded from this area.

With regard to the invertebrate fauna of this area it may be stated that the only invertebrate of economic importance is the prawn, of which there are at least two species.

Another common crustacean in this area is the "bat-lobster" (*Thenus orientalis*). A spider crab (*Egeria arachnoides*) and the common edible crab (*Scylla serrata*) also occur.

A pale-coloured Holothuroid (Sea cucumber) prevails on the muddy ground in this area. This species (*Aphalodactyla mokpadioides*) occurs frequently in (Area III) Orissa waters. The other *Echinoderms* have not yet been identified, and consequently any peculiar features of their distribution are not available.

AREA II.—SOUTH PATCHES LIGHT VESSEL TO AKYAB.

The ground in this area varies considerably. Near the light vessel it was mud, further to the south this becomes replaced in depths from 8 to 17 fathoms by fine glittering sand, with at intervals patches of shells. Off St. Martin's Reef in from 10 to 13 fathoms fishing was carried on on a bottom consisting of shells and fine gravel. Between St. Martin's Reef and Oyster Island the trawl brought up fossiliferous rocks of Miocene Age. The rocky nature of the ground on this coast led to trawling being abandoned, but I am not sure that with suitable gear trawling could not be successfully carried on

here. Specimens of the rocks referred to have been presented to the Geological Survey of India. At the commencement of the haul when these specimens were preserved, Oyster Island Light bore E. by S. $\frac{1}{2}$ S. and the depth was 17 fathoms.

On such variable ground the catches naturally varied a good deal. Near to the South Patches light vessel the fish fauna approximated very closely to that of Area I except that large specimens of the sele fish (*Polynemus plebeius*, an estuarine species, were here obtained. So far as one could judge (the adviser was only able to pay two visits to this area) *Carcharias laticaudus* was the most abundant shark.

A ground shark (*Rhynchobatus djeddensis*) though universally present in the Bay seemed to be more common here than elsewhere.

In a typical haul near the South Patches light ship the following forms occurred:—

Scles: *Cynoglossus macrolepidotus*, *Plagusia marmorata*.

Pomfrets: (*Stromateus cinereus*), *Bummaloes* (*Harpodon nehereus*).

"Small flats:" *Scatophagus argus* (an estuarine form), *Drepane punctata*.

Skates: *Aetobates narinari*, *Pteroplatea tentaculata*, *Trygon uarnak*, *Narcine timlei*, *Trygon sephen*.

Herring family: *Chatoessus chacunda*, *Raconda russelliana*, *Pellona indica*.

Cat-fish ("Gurnards"): *Arius dussumieri*.

"Whiting:" *Sciaenops ocellatus*, *Sillago analis*, *Otolithus ruber*.

"Bekti:" Various species of *Chrysophrys*.

"Halibut:" *Psettodes erumei*.

"Rock Salmon:" *Otolithus maculatus*.

"Congers:" *Muraenesox cinereus*.

Near the light-ship invertebrates were rare. *Squilla raphidea* seemed to be the commonest crustacean. Prawns (*Peneus semisulcatus*—the common prawn and *Peneus indicus* the long beaked prawn) were rarely met with.

Limulus (the King crab) occurs here, as well as on the west side of the Bay.

It may be noted that two *Pleuronectids* previously described by Alcock from the *Investigator* collections also occur in this area, namely:—

Rhomboidichthys azureus previously recorded from Ganjam and Ceylon.

Rhomboidichthys valde-rostratus previously recorded from Ceylon only.

AREA III.—FROM THE MOUTH OF THE DEVI RIVER TO THE ENTRANCE TO LAKE CHILKA.

Here the predominant feature of the bottom was sand. In greater depths mud is met with, but never of the softness of Area I. In the neighbourhood of Konarak there is a reef composed of a recent conglomerate of sand and decomposed shells, where on one occasion the trawl was lost.

Off the Devi river turtles are unusually abundant. No less than six have been taken in a single haul of the trawl.

The two species of turtles recorded from the *Golden Crown* are *Thalassochelys caretta* and *Chelone imbricata*, neither of which is the common edible form.

Sparoid fish are abundant in this area, including species of *Chrysophrys* and the "red-flat" of the *Golden Crown* (*Pagrus spinifer*) occurs more abundantly in this area than in any other, as does *Drepane punctata*, very large specimens of which were obtained.

Large hauls of *Scombridæ* (mackerel) were occasionally made here. The common mackerel of the Orissa Coast (*Scomber microlepidotus*) is somewhat smaller than the European mackerel (*Scomber Scomber*), but is of similar flavour.

Carangidæ, though by no means restricted to this area, are unusually abundant. These fish (horse mackerel) are represented by a large number of species and at least two are new to science (*Caranx guptæ* and *Caranx auricoronæ*)*. Red mullets flourish here, notably *Upeneoides vittatus*. The largest hauls of *Triacanthus* were made towards the southern boundary of this area, off the entrance

*See Records of Indian Museum. Papers by B. L. Chaudhuri, B.A., B.Sc.

to Lake Chilka. This genus is found abundantly in the lake itself.

Of invertebrates, crustacea predominate, the edible prawn occurring in large quantities.

AREA IV.—THE NORTHERN CIRCARS COAST.

Off the Ganjam Coast the conditions are not dissimilar to those on the coast of Orissa.

Sand in the shallow depths and mud in the deeper also occur here. But the further south one goes the more varied the nature of the bottom becomes. Off Gopalpur, for instance, in a depth of 24 fathoms, enormous numbers of shells of *Siliquana torta* and *muricata* were found interwoven into rock-like masses with a Lithistid sponge. The more solid nature of the ground here furnishes a holding place for gigantic fan-like "corals" (*Antipatharia*). A black cork-screw like form (*Cirripathes spiralis*)—the black coral of commerce—is here met with. Other typical forms of this region are *Solenocaulon*, *Rhipidogorgia* and *Eumicella*. A large collection of sponges has been obtained but not yet identified. Hexactinelled forms do not occur, but they are more characteristic of deeper water.

The most characteristic cartilaginous fish of this region are *Trygon kuhlii* and *Trygon zugei*, the latter apparently not being found farther north. *Trygon microps*, probably the heaviest of the Indian rays, is also frequently caught here. On the 9th March about half way between Rati Beacon and Pundi one was caught which weighed about 400 lbs.

It is however the bony fishes which differentiate this region from the others, and whole families are met with here which occur not at all or only in isolated cases further north in the Bay. A few of these may be mentioned.

The snipe-fish (*Centrisida*), are represented by the curious shrimp-fish (*Amphisila scutata*), which does not occur further north. It occurs on the Arakan side to the south of Area III, which area when more thoroughly investigated may prove to have some (or many) features in common with the Ganjam area.

The sea perches are more abundant and represented by a greater variety of forms than in Area III; while *Serranus lanceolatus* appears to be the most widely distributed of

these forms; *Serranus pantherinus* and *latifasciatus* are more restricted to the southern area (IV).

Another perch typical of this area is *Lutjanus marginatus*, and *Scolopsis vosmeri* does not appear to occur further north.

Several of the Chaetodontidae are characteristic of this area, notably *Chaetodon vagabundus* var *pictus*, *Heniochus macrolepidotus* and *Holacanthus xanthurus*. These fish are mostly of small size and brightly coloured. They are typical coral-reef denizens.

Of the sciaenidae, the genus *Umbrina* is here more abundant than in more northerly waters; notably *Umbrina macroptera* was not recorded from any other area.

The Acanthuridae are also typical of this area. Two species have been recorded, namely, *Acanthurus lineatus* and *Acanthurus gahm*.

Here also were taken the only specimens of *muræna* (eel like fish) in the *Golden Crown* collection, namely, *Muræna punctata*, and another not yet identified.

The Berycidae are sparingly represented, and almost exclusively from this area. They are brilliantly coloured fish with spiny gill covers. *Holocentrum rubrum* and *Myripristis murdjan* are typical forms.

The barracudas (*sphyrænidæ*) are also represented here by two species *Sphyræna jello* and *Sphyræna obtusata*.

The file fishes (*balistina*) are represented by *Balistes stellaris* and the copper fish (*Ostracion turritus*) is more common here than elsewhere. All these are practically restricted, at any rate on the west side of the Bay, to this southernmost area.

The holothurian which predominates here is a violet and yellow coloured species (*Colochirus violaceus*).

Amongst the crustacea are the edible spiny lobster (*Panulirus fasciatus*) and a large number of crabs including *Neptunus pelagicus*, *Nsanguinolentus*, *Charybdes crucifera* and *Calappa exanthematosa*.

In the preparation of this section (II) of the report I am much obliged to Dr. Annandale for assistance, particularly in the identification of the various invertebrates.

EXTRACT FROM THE REPORT OF THE 16TH
MARCH 1910 ON THE PROGRESS OF THE
ENQUIRY INTO THE FISHERIES OF BENGAL,

By MR. A. AHMAD, C.S., *Commissioner of Fisheries.*

SURVEY OF THE MARINE FISHERIES OF THE BAY OF
BENGAL BY THE STEAM TRAWLER *GOLDEN
CROWN.*

The trawler named *Golden Crown* was selected by Messrs. W. E. Massey and Sons of Hull under the expert advice of Captain T. G. Seagrave of London, who was deputed by the India Office for the purpose. Before she was sent out she was supposed to be altered and fitted out to suit the climate and other requirements of Bengal. But all the requisite alterations to make her suitable for the tropical climate of the Bay of Bengal could not be found out till the vessel actually arrived in Calcutta. The bunks in the cabin below were not considered suitable for this climate to sleep in and consequently the deck-house had to be erected for affording sleeping accommodation to the European crew. Captain G. Mann, a well-known trawling captain from Hull, who was brought out to be in charge of the vessel and survey operations in the Bay, was of opinion that it would have been impossible to carry on any work in this climate without having the deck-house constructed, and that the accommodation for the European crew was thereby made as good as might have been expected in any trawler of English water out in Bengal waters.

Captain Mann is of opinion that the *Golden Crown* was not an antiquated vessel as the public thought her to be. In fact she was one of the most suitable vessels for the kind of work intended in the Bay of Bengal where the bottom is very soft, she having been fitted with very powerful engines which very few of the vessel of her type had. He further says that any vessel which was built for the English climate would have to go through just the same alterations which the *Golden Crown* has gone through in Calcutta.

From the remarks quoted above it appears that the vessel had been selected after due consideration to the money offered and the kind of work she was expected to do out here.

The vessel was ready to sail by the 10th June 1908 and on the 13th June 1908 with five European crew, one navigating officer and 17 Indian crew and two fishermen the *Golden Crown* made her first trial trip, and on going out met the first monsoon at the mouth of the Bay, but in spite of that she commenced trawling on the 15th June 1908, and proceeded to Balasore Road where she continued her operations at several places. From that time till the end of September 1908, she made several cruises in the west coast to places from Pilot Ridge light vessel to south-west of Puri and in the east coast in the neighbourhood of Elephant Point and East Channel light-vessel with occasional stoppages compelled by the necessity of petty repairs and other incidental difficulties.

The days occupied in actual trawling, the positions of the stations at which the trawl was shot and hauled up together with the time and weather conditions during the operation are shewn in the statement attached as Appendix. I. The conditions of the bottom and the description of the catch are also noted therein.

The most hopeful aspect of the operations is, as it will appear from the Appendix II, that the quantity of catches was steadily increasing.

Some native fishermen apprentices were also taken and their work was very hopeful and satisfactory, but they were of various castes so that they had to cook their own food individually and separately which greatly interfered with the work; so at the instance of the trawling captain they had to be discharged. Up to September 1908, I had to work in this connection single-handed, and on the arrival of the Fishery Advisor to the Government of Bengal, the survey work of the Bay was made over to him and he has submitted an excellent report of the work done under his supervision. (*Vide p. 46.*)

The work hitherto done by the *Golden Crown* goes to prove that the fishing possibilities of the Bay are extensive and that fish could be brought to the markets in quite sound condition for human consumption. By placing the several catches in all the different markets and the different exhibitions all over the province and outside, the sea-fish has been popularised and has created a taste among the fish-eating population which is a great thing in advance of the future working of the Bay on commercial lines.

The specimens of fish hauled up by the trawler have been kept in the Indian Museum, Calcutta, after identification as far as possible within the short period. In fact, the trawling in the Bay has given some new species which had hitherto been unknown to science.

The work hitherto done by the trawler has been mapped out in the accompanying chart. The reference given in the body of the chart explains the details of the result arrived at by the survey undertaken.

The *Golden Crown* was purchased for £4,000 and sold for Rs. 40,000. She was engaged in actual work for 240 days in the two years; she was under our charge at a cost of about Rs. 125 per day. The actual fishing was done for 147 days and the sale fetched Rs. 10,250-8. The total result being about $\frac{1}{2}$ anna per lb. on the entire catch, not certainly a profitable result from a commercial point of view. But if the result secured in England and America and other countries at the start of fishing industry be compared with our efforts here, I venture to assert that our results compare most favourably with those of other countries. I must not forget that other countries had not the same benefits in the shape of first class appliances and men as we possessed, but they had not the same obstacles as we had in the shape of different dues, long stretch of a difficult river to navigate and the prejudices of people to overcome.

We have been able to show that fish in marketable quantity and quality can be had at certain places. We have also shown that they could be brought in fresh condition to the principal market in the capital of the Empire; we have further shewn how the fish could be stored in the town, packed in boxes and sent out to long distances even to Simla and Dacca where they were highly appreciated and were in constant demand. Apart from the scientific results, these are sufficiently helpful to any private enterprise to start a business on purely commercial line.

The practical fishermen led me to understand and I fully agree with them that if five trawlers are employed of the approved type, suitable for use in the tropics, and the catches are brought to places like Diamond Harbour, Port Canning and Balasore and then railed to Calcutta, the result will be very satisfactory and will pay the company 20 to 25 per cent. profit on the outlay.

A private company financed by some Bombay capitalists is anxious to embark on an enterprise of this kind, but instead of five steam-trawlers, they intend to bring out only seven sailing trawlers. When I was asked to give an opinion I expressed my entire disapproval as the Bay is too far from Calcutta, and then the sailers will be useless for trawling purpose in coasts of Bengal. They may answer the purpose towards Madras and Bombay, but certainly not here. Another company is anxious to start the business on a smaller scale by having only two steam-trawlers and half-a-dozen steam-carriers. I am unable to say definitely how this will answer the purpose, but I should have thought that with five steam-trawlers one could use any number as carriers, and no separate carriers need then be employed.

The newspapers in Bengal have all very kindly given their support to my efforts in popularizing the method adopted by me in getting the fish sold. Some of the criticisms have been rather of an unpleasant character; but I accepted them as expressing their real interest in an industry, which they felt was necessary for the benefit of the people of Bengal.

Appendix I to the Report of Mr. A. Ahmad.

APPEN

DATE.	Time shot.	Latitude.	Longitude.	Sound- ing.	Bottom.	Time hailed.	Latitude.	Longi- tude.
1909.								
July 7th ...	10 A.M.	Saugor	Roaf.	Fathoms. 4	Mud ...	11 A.M.	Saugor	Roaf.
" 9th ...	9 ..	20° 55' N	90° 15' E	47	Do. ...	Noon.	20° 55' N	90° 44' E
" 9th ...	7 P.M.	21° 5' N	91° 22' E	27	Do. ...	11 P.M.	21° 0' N	91° 38' E
" 9th ...	10 ..	21° 6' N	91° 35' E	27	Sy. & Sh.	6 A.M. (10)	21° 6' N	91° 50' E
" 10th ...	8 A.M.	21° 11' N	91° 56' E	10	Hard sand and shell.	Noon	21° 21' N	91° 40' E
" 10th ...	Noon	21° 21' N	91° 46' E	12	Hard grey sand.	4 P.M.	21° 27' N	91° 36' E
" 10th ...	10 P.M.	21° 22' N	91° 41' E	14	Sand and shell.	2 A.M. (11)	21° 17' N	91° 35' E
" 11th ...	9 A.M.	21° 15' N	91° 55' E	10	Grey hard sand and mud.	2-30 P.M.	Off Elephant Point.	
" 11th ...	2-20 P.M.	Off Elephant Point.		13	Ditto ...	7 P.M.	Ditto.	
" 11th ...	7-30 ..	Ditto.		12	Hard sand and shell.	5 A.M. (12)	Ditto.	
" 12th ...	5-30 A.M.	Off S. Palchi L. Vessel.		21	Mud ...	Noon	Off S. Palchi L. Vessel.	
" 12th ...	Noon	Ditto.		13	Sand and shell.	5 A.M.	Ditto.	
" 31st ...	11 A.M.	20° 22' N	87° 3' N	16	Dark mud	2-15 P.M.	20° 19' N	87° 9' E
" 31st ...	2-45 P.M.	20° 18' N	87° 11' E	15	Mud ...	7-35 ..	20° 24' N	86° 50' E
Aug. 1st ...	10-30 A.M.	20° 12' N	86° 48' E	23	Do. ,	2 ..	20° 18' N	86° 41' E
" 1st ...	2-30 P.M.	20° 16' N	86° 40' E	13	Do. ...	7 ..	20° 10' N	86° 50' E
" 1st ...	7-30 ..	20° 10' N	86° 50' E	13	Do. ...	Midnight	20° 17' N	86° 54' E
" 2nd ...	12-45 A.M.	20° 16' N	86° 54' E	27	Do. ...	5 A.M.	20° 22' N	86° 50' E
" 2nd ...	7-30 ..	2° 24' N	87° 1' E	25	Sand and shell.	11-30 ..	20° 29' N	87° 8' E
" 2nd ...	Noon	20° 30' N	87° 10' E	16	Cor. mud	7 P.M.	20° 34' N	87° 15' E
" 3rd ...	12-30 A.M.	20° 3' N	87° 5' E	10	Sand and mud.	6 A.M.	20° 4' N	87° 9' E
" 3rd ...	6-30 ..	20° 41' N	87° 5' E	13	Ditto ...	11-30 ..	20° 58' N	87° 17' E
" 3rd ...	2-30 P.M.	20° 54' N	87° 57' E	16	Ditto ...	5-30 P.M.	20° 54' N	87° 54' E
" 3rd ...	6-30 ..	20° 56' N	87° 52' E	21	Ditto ...	Midnight	20° 54' N	87° 58' E
" 4th ...	12-30 ..	20° 56' N	87° 58' E	27	Ditto ...	4 P.M. ...	21° 56' N	86° 5' E
" 4th ...	4-30 ..	21° 56' N	88° 56' E	15	Ditto ..	7 .. ...	...	...
" 18th ...	12-50 A.M.	Ridge L. Vessel, bore W & S 10 miles.		27	Mud ...	5-50 A.M.	L. Vessel E & S	
" 18th ...	6-30 ..	Light Vessel E & S		24	Sand, shell and mud.	11 ..	21° 0' N	86° 30' E
" 18th ...	11-45 ..	21° 0' N	87° 30' E	24	Ditto ...	4-30 ..	21° 2' N	87° 27' E

DIX I.

Soundings.	Bottoms.	Weather.	Sea.	Wind.	Baro- meter.	REMARKS.
Fathoms.						
4	Mud	Strong gale	High	SW	29.59	Saugor; no good for trawling; too many wrecks and rocks.
46	Do.	Moderate gale	Do.	Do.	29.57	Very poor bottom.
37	Do.	Heavy rain, strong wind.	Do.	SE	29.65	Ditto.
17	Mud, sand and shell.	Heavy rain and fresh wind.	Moderate	Do.	29.66	Bottom little better.
12	Sand and shell.	Fine and clear	Ditto	Do.	29.65	Very good ground.
11	Hard grey sand.	Showery and moderate wind.	High	Do.	29.60	Got off the good ground and returning on SE course.
10	Grey sand and shell.	S.-E. gale; high swell, high S.-E. sea.	Do.	Do.	29.70	Net got fouled.
12	Sand and mud.	Moderate S.-W. gale.	Cross	SW & SE.	29.70	Good ground off Ele- phant Point.
13	Ditto	High gale and shipping water	Very high	SW	29.65	Same ground, good for large fish and skate.
23	Mud	Moderate S. W. gale.	High swell	Do.	29.64	This ground is near S. Pulchis Light Vessel and very good; this ground needs fine weather so as to ap- proach very close.
13	Sand and shell.	High swell and moderate wind.	High	Do.	29.65	Same ground good.
8	Mud	Ditto	Do.	Do.	29.60	Net got fouled off Regn. shoal. We lost the catch and net.
16	Do.	Strong breeze	Heavy	WSW	29.45	Fair ground with small fish.
22	Cor. sand	Ditto	Do.	SW	29.40	No fish around; all small.
13½	Mud	Fresh wind	High	Do.	29.41	Good ground; might be larger fish in fine weather.
14	Cor. sand	Moderate breeze	Heavy swell.	Do.	29.41	Same kind of ground.
27	Ditto	Ditto	Ditto	Do.	29.46	Net full of mud and no fish. Steamed NNE.
23	Mud	Fresh breeze, S.-W. swell.	Ditto	Do.	29.48	Net full of sea grass and mud, & basket prawns. Steamed further north.
15	Cor. sand	Moderate wind	Ditto	WSW	29.47	Better ground and better quality of fish and very small fish.
15	Mud	Ditto	Ditto	Do.	29.42	Steamed to the north of False Point.
13	Do.	Ditto	Ditto	SW	29.46	Bad ground; net full of mud and weed and torn; had to mend.
21	Do.	Ditto with rains.	Ditto	Do.	29.46	Bad ground. No fish.
13	Do.	Fresh wind	Heavy	...	29.65	Fair ground; will try again.
27	Do.	...	...	...	...	...
15	Do.	...	...	...	...	...
...	...	...	...	...	...	Boards of trawl turned over, fouling net, had hard work to get it clear to haul up; 8-30 p.m. net hauled up and found it badly damaged.
24	Sand, shell and mud.	Moderate wind	High	SW	29.57	Fair ground, but strong tide; vessels going too fast through water.
20	Ditto	Light breeze and clear.	Heavy swell.	WSW	29.59	Good ground; fair catch; will go back over same ground.
20	Ditto	Light breeze and cloudy.	Moderate swell.	SSW	29.50	Fair ground and catch small fish, going over ground again.

DATE.	Time shot.	Latitude.	Longi- tude.	Sounding.	Bottom.	Time hauled.	Latitude.	Longi- tude.
1906.				Fathoms				
Aug. 18th ...	5 P.M. ...	21° 0' N	87° 27' E	24	Sand, shell and mud.	Midnight	20° 59' N	87° 33' E
" 18th ...	12-30 A.M.	20° 59' N	87° 33' E	19½	Sand and mud.	6-15 A.M.	Ridge L. Vessel, east 8 miles.	
" 19th ...	7 0 "	Ridge L. Vessel, east 8 miles.		24	Ditto ...	11-30 "	21° 4' N	87° 34' E
" 19th ...	12-15 P.M.	21° 4' N	87° 34' E	18	Sand, shell blk. sp.	5-45 P.M.	21° 6' N	87° 32' E
" 19th ...	15 "	21° 6' N	87° 32' E	17	Ditto ...	...	"	"
" 20th ...	.....	"	"	...	"	12-45 A.M.	21° 8' N	87° 36' E
" 20th ...	1-20 A.M.	21° 8' N	87° 36' E	17	Sand and mud.	6-30 "	20° 53' N	87° 33' E
" 20th ...	7 "	20° 53' N	87° 33' E	18	Sand blk. sp.	Noon ...	20° 45' N	87° 45' E
" 20th ...	12-30 P.M.	20° 46' N	87° 45' E	23	Mud ...	5 P.M.	20° 47' N	88° 5' E
" 20th ...	5-20 "	Ridge L. Vessel, N N W 2 miles.		30	Do. ...	11 "	L. Vessel, S E 3 miles.	
" 21st ...	6-30 A.M.	Ridge L. Vessel, bore N N W 2 miles.		27	Sand and mud.	11-45 A.M.	L. Vessel, S E 3 miles.	
" 21st ...	Noon ...	Lt. Vessel, bore S E 3 miles.		24	...	6-30 P.M.	21° 58' N	88° 0' E
" 26th ...	2-30 P.M.	20° 34' N	89° 44' E	70	Sand and mud.	3 "	20° 34' N	89° 41' E
" 26th ...	6-30 "	20° 36' N	89° 47' E	72	Ditto ..	7-30 "	20° 34' N	89° 40' E
" 27th ...	12-15 "	20° 46' N	91° 57' E	23	Green mud	3-15 "	20° 36' N	92° 5' E
" 27th ...	4-20 "	20° 37' N	92° 12' E	13	Ditto ...	7 "	20° 28' N	92° 15' E
" 28th ...	6 A.M.	20° 46' N	92° 10' E	17	Mud ...	9-15 A.M.	20° 36' N	92° 7' E
" 28th ...	9-45 "	20° 36' N	92° 7' E	20	Do. ...	2 P.M.	20° 46' N	92° 9' E
" 28th ...	2-30 P.M.	20° 47' N	92° 0' E	27	Do. ...	7 "	21° 0' N	92° 5' E

Sounding.	Bottom.	Weather.	Sea.	Wind.	Barom.	REMARKS.
Fathoms.						
19 1/2	Sand and mud.	Moderate wind with rain squalls.	Moderate swell.	SW ...	29.54	Fair ground, but all small.
24	Ditto ...	Moderate wind; dull; cloudy.	Moderate	West ...	29.52	Similar ground, but few fish about.
18	Sand, shell blk. spn.	Same weather	Ditto ...	Do. ...	29.50	Captain reports this good ground; caught large sword fish which damaged nets badly.
17	Ditto ...	Moderate variable wind and heavy rain.	Ditto ...	West to SSW.	29.45	Fair ground but small catch; caught two small sharks.
...	...	Fresh wind and heavy rain.	Rough ...	SW ...	29.42	} Good ground but heavy sea unsettled weather; fish disturbed; small catch.
17	Sand and mud.	Strong breeze and heavy squalls.	Do. ...	Do. ...	29.45	
18	Sand blk. spk.	Moderate gale and heavy rain; squally weather.	High ...	Do. ...	29.52	Very small catch; sea much disturbed.
26	Mud ...	Same weather	Do. ...	WSW ...	29.53	Not such good ground; caught one large shark.
30	Do. ...	Fresh wind and squally.	Rough ...	SW ...	29.47	Very bad haul; the sea much disturbed.
20	Do. ...	Strong wind and cloudy with rain.	Do. ...	Do. ...	29.54	9-45 P. M. driver allowing engine to stop; net sank in the mud and had hard work to heave it up; after getting net up had to let it over the side to get mud out of it, therefore spoiling fish. (Captain decided not to shoot till daylight.
24	Sand and mud.	Fresh wind; heavy rain; cloudy.	Do. ...	Do. ...	29.53	Very poor haul; although ground good, no fish.
16	Mud ...	Fresh breeze and cloudy.	Moderate	Do. ...	29.58	Small catch; ground soft mud.
70	Sand and mud.	Moderate breeze.	Rough ...	SSW ...	29.48	After paying out 210 fathoms wire owing to strong under-currents of the sea, the doors became locked, had to heave up again. Nets very badly torn, had to repair.
70	Ditto ...	Moderate S SW breeze and rain showers.	Do. ...	Do. ...	29.50	We just ran one hour on this as a trial to see if there was any large fish in this deep water, but there was nothing but a few small whiting in the net, so decided to steam into less water.
18	Green mud	Moderate wind; fine clear weather.	Moderate	SE ...	29.48	Fair haul and better quality of various kinds of fish, but very soft ground; tried closer to Reef for better bottom.
11	Mud ...	Fresh wind and rain; dull, cloudy weather.	Ditto ...	Do. ...	29.50	Very poor haul, though we should have had better being close to Reef, but net full of mud through steam going down and slowing net to sink.
20	Do. .	Moderate breeze and fine weather.	Ditto ...	ESE ...	29.58	Fair catch; good fish, various kinds; caught one turtle but ground soft.
27	Do. ...	Fresh breeze, dull, cloudy, sky overcast.	Ditto ...	SE ...	29.58	Very poor haul; there seems to be no fish in deep water, but bottom very soft.
23	Do. ..	Blowing moderate gale and heavy rain.	High ...	SSE ...	29.58	Very soft ground and no fish; sea much disturbed. Too bad weather have vessel to.

Date.	Time shot.	Latitude.	Longitude.	Sounding.	Bottom.	Time hauled.	Latitude.	Longitude.
1908.								
Aug. 29th ...	11 A.M.	20° 34' N	92° 1' E	10	Dark sand	2:15 P.M.	21° 40'	91° 58' E
.. 29th ...	3 P.M.	21° 51' N	91° 58' E	16	Sand ...	4:45 ..	21° 42'	92° 2' E
.. 29th ..	5-15 ..	21° 49' N	92° 2' E	17	Do. ...	6 ..	21° 38'	91° 59' E
.. 30th ...	Noon.	21° 26' N	91° 48' E	13	Sand blk spk.	4 ..	21° 20' N	91° 48' E
.. 30th ...	4:45 A.M.	21° 20' N	91° 48' E	13	Ditto ...	11 ..	21° 18' N	91° 52' E
.. 31st ...	6-15 A.M.	21° 26' N	91° 48' E	15	Sand ...	Noon ...	21° 22' N	91° 48' E
.. 31st ...	12-20 P.M.	21° 22' N	91° 48' E	13	Do. ...	5 P.M. ...	21° 18' N	91° 54' E
.. 31st ...	6 ..	21° 18' N	91° 54' E	10	Sand and mud.	11 ..	21° 26' N	91° 48' E
Sept. 1st ...	6-30 A.M.	21° 28' N	91° 46' E	17	Ditto ...	11 A.M. ...	21° 22' N	91° 50' E
.. 1st ...	11-25 ..	21° 22' N	91° 50' E	10	Ditto ...	5 P.M. ...	21° 18' N	91° 52' E

DATE.	Time shot.	Latitude.	Longitude.	Sounding.	Bottom.	Time hauled.	Sounding.	Bottom.
1908.								
Sept. 15th ..	8 A.M. ...	20° 58' N	88° 3' E	11	Mud ...	11-30 A.M.	9	Sand mud.
.. 14th ..	3-45 P.M.	20° 56' N	91° 41' E	22	Do. ...	5-45 P.M.	20	Mud ...
.. 14th ...	6-15 ..	20° 51' N	91° 51' E	19	Do. ...	11 ..	19	Do. ...

Sounding.	Bottom.	Weather.	Sea.	Wind.	Barometer.	REMARKS.
Fathoms						
16	Sand ...	Strong wind and heavy rain squalls.	High ...	S E ...	29.70	Good hard ground but very little fish; sea disturbing the fish.
17	Do. ...	Same weather	Moderate	Do. ...	29.67	Had to haul through strong sea and tide; vessel could not make headway.
17	Do. ...	Strong with heavy rain showers.	Do. ...	S S E ...	29.65	Had to haul through letting steam go back; vessel not able to make headway; net becoming fast in mud after hard working in getting net up, found to be badly torn. Captain decided to lay to for the night, not wanting to lose nets.
13	Sand blk. spk.	Fresh breeze, cloudy weather, with rain.	Rough ...	Do. ...	29.68	This good ground; larger fish, but cannot depend on steam.
13	Mud ..	Same weather	Do. ...	S E ...	29.72	Fair ground and catch, but had to haul nets on account of steam going back allowing nets to become fast in mud. Captain decided to shoot no more as cannot depend on steam and might lose our gear.
13	Sand ...	Moderate breeze, fine clear weather.	Light ...	Do. ...	29.72	This very good ground; had good haul of large fish going same ground. One turtle.
10	Sand and mud.	Same weather	Do. ..	South ...	29.68	Good ground and a fair size fish caught. One very large sword fish which was right across the mouth of the net which would be stopping other fish from getting in and keeping pocket open. Might have had more fish. The length was 22 feet, breadth 10 feet.
13	Do. ...	Moderate variable breeze and rain showers.	Smooth ...	Variable	29.68	Good ground, but rather unfortunate in picking up the same large sword again; had to cut net away a good deal to get him have clear; after two hours' work, got him on deck to cut up.
10	Sand ...	Light variable breeze, fine, clear.	Do. ...	Do. ...	29.72	Fair ground and haul, but very poor steam kept to trawl with.
10	Sand and mud.	Moderate breeze, clear weather.	Do. ...	South ..	29.68	Fair ground, but not much fish for the ground we have been over; decided to shift ground. 5.30 P.M. steamed away W and S.

Latitude.	Longitude.	Weather.	Sea.	Wind.	Barometer.	REMARKS.
20° 56' N	88° 12' E	Light breeze and fine.	Smooth ...	SE ...	29.67	Very poor haul; engine, going too slow; net full of mud.
20° 46' N	91° 56' E	Moderate wind and fine.	Do. ...	South .	29.72	Fair haul and good fish; will try same ground again.
20° 48'	93° 0' E	Same weather	Do. ...	SSE ...	29.74	Small catch but good fish; ground good.

DATE.	Time shot.	Latitude.	Longitude.	Sound- ing.	Bottom.	Time had Rod.	Sound- ing.	Bottom.
1908.				Fathoms.		Sept. 5th.	Fathoms.	
Sept. 14th ...	11-20 P.M.	20° 43' N	92° 0' E	19	Mud	5-45 A.M.	24	Mud ...
.. 15th ...	6-15 "	20° 44' N	91° 50' E	24	Sand mud	11-45 "	30	Do. ...
.. 15th ...	Noon ...	20° 41' N	91° 56' E	20	Mud	5-30 P.M.	19	Do. ...
.. 15th ...	6-15 P.M.	20° 31' N	92° 5' E	19	Do.	11-30 "	19	Do. ...
.. 15th ...	12 "	20° 51' N	91° 54' E	19	Do.	Sept. 16th. 5-30 A.M.	18	Do. ...
.. 16th ...	7-40 A.M.	21° 4' N	91° 46' E	13	Sand, mud	11-30 "	10	Sand, mud
.. 16th ...	Noon ...	21° 15' N	91° 49' E	10	Ditto	5-30 P.M.	10	Ditto...
.. 16th ...	7-45 P.M.	21° 11' N	91° 47' E	20	Mud	11-30 "	25	Ditto...
.. 16th ...	10-15 A.M.	20° 56' N	88° 5' E	19	Sand, mud	2-10 "	18	Mud ...
.. 16th ...	2-35 P.M.	20° 52' N	88° 0' E	18	Ditto	5-30 "	10	Do. ...
.. 16th ...	5-50 A.M.	20° 58' N	88° 4' E	10	Ditto	9 "	16	Sand ...
.. 16th ...	9-45 P.M.	21° 4' N	87° 44' E	16	Ditto	Sept. 19th. 1 A.M.	16	Do. ...
.. 16th ...	1-30 A.M.	21° 10' N	87° 35' E	15	Ditto	5-50 "	10	Mud ...
.. 16th ...	6-15 "	21 14' N	87° 40' E	10	Ditto	10-30 "	13	Do. ...
.. 16th ...	10-30 "	21° 7' N	87° 40' E	13	Ditto	2-30 P.M.	16	Do. ...
.. 16th ...	2-55 P.M.	20° 59' N	87° 51' E	16	Ditto	6-50 "	27	Do. ...
.. 20th ...	3 "	20° 50' N	88° 4' E	15	Sand, mud	5-30 "	15	Sand, mud.
.. 20th ...	6 "	21° 0' N	87° 48' E	15	Ditto	6-45 "	16	Ditto.
.. 20th ...	1 A.M.	21° 8' N	87° 30' E	15	Sand, mud and shell.	5-30 A.M.	16	Sand, mud and shell.
.. 20th ...	6 "	21° 0' N	87° 32' E	16	Ditto	10 "	15	Ditto.

Latitude.	Longitude.	Weather.	Sea.	Wind.	Baro. meter.	REMARKS.
20° 41' N	92° 5' E	Moderate breeze, cloudy with rain showers.	Smooth ...	SE	29.76	Small haul and small fish. Captain cannot understand after getting such good fish before.
20° 41' N	91° 58' E	Same weather	Do. ...	SSE	29.76	Very poor haul for the ground we have been over and no big fish to be caught.
20° 33' N	92° 3' E	Light breeze and fine.	Do. ...	SSW	29.72	Small haul and caught one large sword fish which damaged the net badly.
20° 50' N	91° 54' E	Light breeze, cloudy with heavy rain.	Do. ...	SE	29.70	Small haul; will try other ground further north.
20° 56' N	91° 46' E	Same weather	Do. ...	Variable	29.70	Same kind of haul and fish, steaming north; Captain cannot understand it after being over so much.
21° 18' N	91° 40' E	Light breeze and rain.	Do. ...	South	29.72	Good ground and no fish. Caught one turtle this haul.
21° 13' N	91° 52' E	Moderate breeze and rain.	Light ...	SSW	29.68	Satisfied that there are no fish here; steamed away WSW.
21° 4' N	91° 40' E	Same weather	Moderate	SW		Disgusted with this fishing; one basket for five hours; engine full speed ahead and set course for west side of the Bay; no fish this side.
20° 50' N	88° 11' E	Light breeze with rain.	Smooth	Variable	29.70	This very good ground and good haul, large of small fish more fish on this side of the Bay.
20° 58' N	88° 4' E	Light breeze with fine.	Do.	ENE	29.67	Very good haul and good fish along this western Beach.
20° 44' N	88° 15' E	Moderate breeze.	Do. ...	East	29.68	Very poor haul; one large sword fish damaging net.
21° 10' N	87° 35' E	Same weather	Do. ...	SSW ...	29.70	No haul this time; vessel going too quick; no fish.
21° 5' N	87° 40' E	Light wind and fine.	Do. ...	Do. ...	29.73	Very poor haul this, ought to be more fish this ground.
21° 7' N	87° 46' E	Same weather	Do. ...	SSE ...	29.70	Very fair haul, but small fish and skate.
21° 0' N	87° 51' E	Moderate breeze.	Do. ...	SW ...	29.67	Fair haul and good ground.
20° 58' N	87° 40' E	Same weather	Do. ...	Do. ...	29.68	Fair haul but small fish. Hauled to wh on board after trawling on both to the eastward between Elephant Point and Shapur and finding little fish, steamed to the westward along the western Beach and finding more fish and better quality.
21° 0' N	87° 50' E	Light breeze, and cloudy.	Smooth ...	East ...	29.67	Fair haul and good fish but very strong tide.
21° 3' N	87° 48' E	Same weather	Moderate	SE. ...	29.60	Had to haul net, tide too strong and stream letting stream back.
21° 1' N	87° 35' E	Light breeze, cloudy with heavy rain.	Do. ...	EE ...	29.62	Fair haul of good fish and good hard fishing ground.
21° 3' N	87° 21' E	Moderate and cloudy.	Light ...	Do. ...	29.66	Very good hard ground, but poor haul on account of nets being torn, whether with weight fish that had been in or the ground could not say, but very good fish what we got. Decided to proceed home on account of mate lying very bad and nets torn.

Appendix II to the Report of Mr. A. Ahmad.

APPENDIX II.

Statement showing the quantity of fish deposited daily in the cold store.

Date.	Species.	Quantity.	Mds. srs.	Mds. srs.
1908.				
7th August	5 Bogo fish	0 32		
	11 Sankar	0 35		
	Small fish	2 32		
		—	4	19
8th	20 Bogo	156 lbs.		
	Small fish	9 cwt. 11 "		
		— about	14	12
			Mds. srs.	
9th	12 Bogo fish	1 20		
	3 Bhetki	0 30		
	26 Sankar	1 22		
	Miscellaneous fish	5 12		
		—	9	4
11th	2 Boxes containing—			
	6 Sankar and small fish		3	1
12th	1 Box containing small fish		0	32
17th	Ditto ditto		1	15
19th	Ditto ditto		0	35
22nd	Skate	6 37		
	Whiting	1 33		
	Tangra or gurnet	10 3		
		—	18	33
23rd	3 Boxes of small fish			
	weighing	...	5	3
	Bhetki	6 19		
	Bastard pomfret	7 31		
	Gurnet	2 6		
	Whiting	7 6		
	Rock Salmon	2 16		
	Prawns and lobsters	0 11		
	3 Eels, mackerel, pomfret and soles	3 8		
		—	29	17
27th	1 Box of small fish	...	1	0
29th	Ditto ditto	...	1	10
31st	Ditto ditto	...	0	31
			—	—
4th September	Tangra	5 39		
	126 Skate	14 35		
	Rock salmon	4 13		

Date.	Species.	Quantity.		
1908.	.	Mds. ars.	Mda. ars.	
4th September— <i>cnckd.</i>	Bastard pomfret ...	2	4	
	Sole ...	0	38	
	Gang balia ...	0	30	
	7 Eels ...	0	21	
	16 Salia ...	3	28	
	19 Bhetki ...	1	26	
	1 Tortoise ...	0	30	
	1 Chakoli ...	0	3	
	4 Dolphin ...	0	6	
	Whiting ...	3	30	
	Bangli ...	0	22	
	Miscellaneous ...	0	18	
			40	23
14th September ...	1 Box of small fish weighing ...		1	29
17th „ ...	Ditto ditto ...		1	0
21st „ ...	Bumalo ...	6	10	
	Rock salmon ...	5	5	
	Lobster ...	0	36	
	Whiting ...	2	10	
	Shark ...	2	0	
	Balia ...	3	11	
	Tortoise ...	1	7	
	Bhetki ...	4	25	
	Small flat ...	4	8	
	Eel ...	3	0	
	Plaice ...	1	28	
	Sole ...	1	6	
	Pomfret ...	1	2	
	Herring ...	1	14	
	Skate ...	13	38	
	Gurnet ...	5	18	
			57	13
22nd September ..	1 Box of small fish ...		1	24
27 „ ...	Ditto ditto ...		1	20
28 „ ...	Prawn ...	0	15	
	Bumalo ...	0	16	
	Bhetki ...	2	12	
	Rock salmon ...	2	10	
	Pomfret ...	0	16	
	Small flat ...	0	14	
	Gurnet ...	0	28	
	Whiting ...	1	15	
	Skate ...	1	0	
			9	6
29th September ..	2 Boxes of small fish and 2 eel and 2 bhetki ...		3	20

EXTRACT OF THE SPEECH MADE IN THE
BENGAL LEGISLATIVE COUNCIL AT THE
BUDGET DEBATE ON THE 15TH APRIL 1909, .

By the HON'BLE MR. F. W. DUKE, I.C.S., *Chief Secretary to Government.*

* * * * *

"I have to refer to the Fisheries inquiry, for which the allotment stands at Rs. 1,65,000, on which some observations have been made by the Hon'ble Rai Kishori Lal Goswami Bahadur and the Hon'ble Babu Doba Prasad Sarbadhikari.

"I would note first that about half the expense is occasioned by the *Golden Crown*. Regarding the operations of this vessel, there appears to be a certain amount of misconception. Attention has been directed to the fact that she is of antiquated type, and less efficient than the most modern builds of trawlers, particularly in being able to shoot her nets only on one side. The misconception consists in supposing that Government would attempt in an experiment limited as to scope and time to prove by actual results that deep-sea fishing pays. What has been attempted, is to ascertain what fish there are in the Bay, where they are to be found at particular seasons, whether they are acceptable to the market, and in what quantities they can be caught. If it were merely desired to show what could be made out of fishing, we should, of course, stick to the nearest rich ground, fish it as hard as possible, and try to show how much could be got from it. What has been done is quite different, namely, to search the Bay up and down, trawling in every part of it where trawling is possible, and to chart and record the results. When this has been done for one or two seasons (it was proposed originally to carry on the experiment for about 18 months in all, but as a matter of fact our information is already, perhaps, sufficiently complete, as far as the Bengal portion of the waters is concerned, and it may be possible to sell, or at any rate to pay off, the trawler a good deal earlier), the public will have complete information as to the fish of the Bay, and the quantity which can be taken at a single haul. It will then rest with those who have the capital and enterprise to devise the best type of vessel for Indian waters, the way in which she should be manned, and the most economical manner of bringing the fish to market."

EXTRACT FROM THE LETTER No. 2506, DATED
25TH AUGUST 1910, FROM THE GOVERNMENT
OF BENGAL, TO THE GOVERNMENT OF
INDIA, REPORTING ON FISHERY INVESTIGATIONS
IN BENGAL.

In these reports Mr. Gupta, furnished a mass of information and put forward various recommendations. The conclusions arrived at by the Lieutenant-Governor on these reports were that, as regards the estuaries and open sea, it was necessary for Government to lead the way, to ascertain the localities in which fishing would be profitable, and to determine the methods on which they could best be conducted. In the fresh water fisheries, no new methods of capture were needed; and it was held that the work of Government should be confined to artificial propagation, combined perhaps with a system of short close seasons and other protective measures. To give effect to these views it was decided to obtain a steam trawler for the marine and estuarine enquiries, to engage the services of a fishery expert, and to depute two selected students—one to Europe to study the curing of fish, marine hatcheries and carp culture, the carp family being represented in Bengal by the *rahu*, *katla* and other important species, and the other to America for instruction in the culture of shad of which family the *hilsa* is a member. In February 1908 Mr. Gupta left to take up his appointment in the Council of the Secretary of State and Mr. Ahsan ul din Ahmad, a Statutory Civilian, was appointed to carry on the operations under the designation "Commissioner of Fisheries." The steam trawler *Golden Crown* reached Calcutta in April 1908, and operations in the Bay were commenced in the following June after the trawler had undergone certain necessary repairs and alterations. The fishery expert, Dr. J. T. Jenkins, arrived in October 1908, and was placed in immediate charge of the marine and estuarine fishery survey. The two students, Mr. Bepin Bihari Das, M.A., and Mr. Saiyid Muhammad Mohsin, were sent out in May and September 1908, respectively, and returned to this country in October 1909. A Fishery Board was also constituted in October 1908, consisting of certain Government officers and representatives of the commercial

community and the landed gentry, whose functions were mainly to advise and assist the officer in charge of the operations and to stimulate public interest in matters concerning fisheries.

The fishery survey of the Bay of Bengal was closed by the end of December 1909. The European crew of the steam trawler and Dr. Jenkins have returned to Europe and Mr. Ahmad reverted to general duties on the 1st April 1910, after submitting his report to which are appended two reports by Dr. Jenkins on marine and estuarine fisheries. These reports are now under the consideration of this Government and will be submitted to the Government of India in due course. In accordance with the arrangement prevailing in most European countries, the control of the Fishery Department has been made over to the Director of Agriculture.

The marine survey has shown that the Bay will yield an ample supply of fish, and that the catches can be put on the Calcutta market in good condition; a chart has also been prepared which shows the best fishing grounds. Government cannot do more in this direction and it remains for private enterprise to take advantage of the results so far obtained. With the sanction of the Government of India arrangements have been made for the issue of salt free of duty for purposes of fish-curing, in order to encourage this industry which is carried on by the fishermen of the Orissa coast. With regard to estuarine fisheries a certain amount of information has been collected, but much remains to be done.

* * * * *

SEA-FISHING.

[A Lecture delivered before the Asiatic Society of Bengal on 17th February 1909.]

*By J. Travis Jenkins, D. Sc., Ph. D., Fishery Adviser to
the Government.*

I.

It is a somewhat difficult matter to select from the wealth of material at one's disposal sufficient to give a brief and intelligible account of modern sea-fishing. Even if the attempt were confined to an indication of the principal methods of fishing in North-Western Europe, where sea-fishing has attained its highest development, our time would be fully occupied and the result would probably be unsatisfactory.

Premising then that much must be omitted and that all must be lightly touched upon, it may at the outset be explained that an attempt will be made to give some idea of modern methods of catching fish on a large scale for purposes of sale, and then a short time will be devoted to outlining the aims of Fishery Science.

In commercial fishing naturally every effort is made to catch as much fish in as short a space of time and with as little expense as possible, regardless of what the consequence may ultimately be as to the future yield of the fisheries. Fishery Science is devoted to the study of the many problems of marine biology and hydrography which have, or may reasonably be supposed to have, some bearing on the maintenance of our fish-food supply. For lack of a better term, I have entitled this study "scientific" sea-fishing, though strictly speaking many of the observations and experiments are not fishing at all.

Modern commercial sea-fishing methods may conveniently be grouped under three headings:—

- (1) A method involving the use of a movable or drag-net, the highest modern development of which is the trawl.
- (2) A method involving the use of a fixed net, which has developed into "drift netting."
- (3) The use of baited hooks attached to lines.

While there are many other modes of fishing, one is not far from correct in saying that as a means of supplying the markets of our huge industrial centres, they are negligible, and were it not for the above three methods, and particularly the first two, trawling and drifting, the European proletariat would be unacquainted with the taste of fresh sea-fish.

All these three methods of fishing are of considerable antiquity, and in common with most other industries, each has in the last quarter of the nineteenth century undergone a remarkable change, due to the appearance of two new factors—steam and the capitalist.

The fisherman of independent and picturesque type, so favourite a theme of artists and poets, who, with his little sailing vessel, fished in the immediate vicinity of his own village, is fast being replaced by the paid "hand" of a limited liability company whose knowledge of seamanship is too often on a par with that of a cowboy, and who fishes in a nondescript garb of which the most prominent constituents are a "bowler" hat, a jersey and clogs. No painter has yet been bold enough to portray his features, and we yet await the Kipling who will reduce to writing his vigorous language.

The year of the great Fishery Exhibition of London (1883) serves as a convenient landmark for separating the old order of things from the new. Previous to that year, the bulk of the fish consumed in the British Isles, or exported therefrom, was caught in the North Sea or in the neighbourhood of our coasts, and by sailing vessels, whereas since that time there has been a rapid supplanting of sail by steam and a gradual extension of the area fished over. The result of the last twenty-five years' progress has been to make sea-fishing a highly technical trade, so much so, that a fisherman now-a-days is only acquainted with one method of fishing and often even of only a particular part of that method. On modern steam vessels not rarely it is the master alone who knows how to fish—the "hands" merely obeying his commands.

Of the three methods referred to, trawling results in the landing of the largest quantity of fish and consequently will best repay our attention.

Drifting is designed to capture those fish which, like the herring and mackerel, live at or near the surface. A fleet of nets, as used on a modern steam drifter, is often three miles

in length and over ten yards deep. The weighted net, which is shot at night and fished at dawn, is supported on a line carrying cork floats, and this line is attached in turn to ropes fastened to buoys. The whole net forms a vertical wall which drifts with the tide. The fish strikes against this and its head passes through, the increasing diameter of its body pulls it up and it is firmly fixed. It cannot push its way through, and if it try to wriggle backwards, it is caught by the gills.

Lining requires little explanation: a steam liner may have a line 7 miles long with 7,000 baited hooks. The hooks are attached at intervals to the main line by means of short pieces of line called "snoods." The line is shot at night and usually fished in the morning. Lining can be carried on off a rocky coast where trawling would be impossible. The original type of trawler was the smack. Many of these vessels are still fishing, but every year their number decreases, so that possibly in the future all trawling will be carried on by steam or motor vessels. The smack uses the original form of trawl, which, as the mouth of the net was attached to a heavy beam of wood, is called a 'beam trawl.' The only smacks which have successfully adopted the newer form of trawl, 'the otter trawl,' are the Germans.

The modern steam trawler is fitted up with this new form of trawl, called the 'otter trawl' on account of the large otter boards which keep the mouth of the net open when the vessel is steaming. The development of steam trawling has of late years been remarkable. From documentary evidence it appears that the trawl was used as early as the fourteenth century, but for a considerable period it was confined to inshore waters. At the end of the 18th century, Brixham was the trawling head quarters. In the 19th century the Brixham men gradually extended their efforts eastwards and eventually found their way into the North Sea on to the famous Dogger Bank. In 1837 the discovery of the famous Silver Pits, to the southward of the Dogger, firmly established trawling as a highly successful method of fishing. The discovery of these famous haunts of the sole led to the development of the east-coast fisheries and to Grimsby and Hull taking the premier position amongst English fishing ports. Grimsby, which was non-existent as a fishery port 50 years ago, is now the largest in the world, about $3\frac{1}{2}$ million cwts. of fish being annually landed there, of the value of not less than 3 millions sterling.

After the discovery of the Silver Pits trawling developed in a northward and eastward direction. The Dutch, Schleswig Holstein and Danish coasts were in turn exploited, and ultimately the Great Fisher Bank to the northward of the Dogger. In 1891 some bold spirits paid a visit to Icelandic waters, and so successful was fishing on these grounds that at the present day 25 per cent. of the trawl-caught fish landed on the east coast of England comes from Iceland. With this increase in the area exploited, we have an increase in the depth at which commercial trawling is carried on, due to more powerful vessels and improved gear. In the first quarter of the nineteenth century the British trawling fleet did not exceed 200 vessels, and they were small sailing craft. In 1883, the year of the Exhibition, this number had increased to 3,000, all sail. The number of trawlers at present is about the same, but half of them are steamers, and it is estimated that their catching capacity is equivalent to 12,000 vessels of the 1883 type.

Naturally, the enormous success which has attended trawling has led to its adoption by other nations, in many cases after Government subsidised vessels have shown the way.

Amongst the notable investigations into practical problems affecting the sea-fishing industry which have been carried on by Government aid, are those of the Russian Government on the S.S. *Andrei Peroswanny* off the Murman Coast; the French expedition to the west coast of Africa on the *Guyane*; the Cape Colony Government on the *Pieter Faure*, and the Dutch exploration of Javanese waters on the *Gair*, and, of course, the *Golden Crown*. Remarkable hauls have been made in temperate and sub-arctic seas. A German trawler off Cape Kanin got 68 tons of fish in 9½ days. English trawlers in Barents Sea got from 90 to 100 tons in a very short time, and on the Agulhas Bank, off the Cape, 7 tons have been caught for 7¼ hours' fishing.

The only trawling results with which I am acquainted which afford comparison with those of the *Golden Crown* in the Bay of Bengal, are the French hauls on the *Guyane*. Here, off French West Africa, we get true tropical fish. The fauna bears considerable similarity to that of Indian waters, at any rate as far as the genera are concerned. In addition to the true sole, the *Guyane* got large quantities of both *Synaptura* and *Cynoglossus*, both of which are taken by the *Golden Crown*; in fact, the common sole of the Bay is *Cynoglossus macrolepidotus*. The presence of numerous

Sciaenoids of the genus *Sciaen*, of Serranidae, and other perch-like forms, make the comparison still more striking. Mulletts were also abundant. All these genera are found in Bengal waters. Full details are not given in the published reports, but Gravel, the leader of the expedition, expressed himself as highly satisfied with the results. It would serve no useful purpose to refer here to the *Golden Crown*, but, as will be seen presently from theoretical considerations, fish life is not likely to be as abundant in tropical as in sub-arctic waters, though this statement does not necessarily imply that commercial fishing on a large scale cannot be made a success. I should like, however, to utter a word of caution. Many people who make a few voyages in tropical waters occasionally see a few flying fish or other surface living forms disporting themselves, and they jump to the conclusion that the sea is full of fish. A few of these folk talk lightly of taking a vessel out into the Bay and (as they elegantly express it) filling her up in twenty-four hours. Although it is rash to prophesy, I may say that in my opinion that will never be done, at any rate by trawling.

What drift netting can accomplish remains to be seen—possibly surface fish are more numerous than demersal forms: on the other hand, possibly not.

II.

The enormous increase in recent years of man's destructive methods of fishing has focussed the attention of zoologists on the problems of marine biology. For many years investigators have worked at marine biological problems, and many expeditions have been equipped by Governments, learned societies, and private individuals for the study of the physics, chemistry and biology of the sea, but it is only quite recently that organised efforts have been made to elucidate problems of direct practical importance to the sea fisheries. Practically all civilised countries with a seaboard have framed regulations for the control of, and taken measures to encourage the development of, the sea fisheries within their territorial waters, and although too often in the past these steps have been based on misconceptions, at the present day the rational, detailed and systematic study of fishery problems is giving us considerable information which will be available for future regulation and improvement of the fisheries. Even to give a list of the bodies

which devote themselves to this kind of work would take up too much time: it may suffice to mention that the pioneers were the Scottish Fishery Board, the Kiel Commission, and the United States Fish Commission. Nearly every nation has now well-equipped marine stations provided with all the apparatus necessary for the study of marine problems, and very few are unprovided with a steamer or steamers specially constructed to deal with investigations of this sort. A good example of a steamer which combines scientific investigation with practical fishing is afforded by the Dutch Government steamer the *Geir*, which is at present investigating Javanese waters.

The scientific study of the sea fisheries has for its main object the estimation of the effect of man's intrusion into the complicated struggle for existence which goes on amongst marine organisms. In particular, it is necessary to determine in such seas as the North Sea, where the intensity of fishing is very great, what the ratio of the quantities of fish captured is to the quantity produced under the prevailing conditions, and if any extreme disproportion exists (between capture and production) how such proportion can best be obviated. It is obvious that such a study involves the accumulation of much material, not only must one have an accurate knowledge of the species of marine organisms and the conditions under which they live, — physical, chemical and bionomical, — but it is also necessary to apply quantitative methods of research to this material.

In addition to the description of the species of marine animals and plants, which after all is but a means to an end, it is necessary to become acquainted with their environment. This involves a knowledge of marine sediments, of the temperature, salinity and gaseous contents of sea water, of commercial fishery statistics, and other matters. With so many problems of interest to select from, it is difficult to know where to commence, but some attempt will be made to convey an idea of how the productivity of the sea is estimated.

Professor Hensen of Kiel originated the idea of making a census of the sea, and the questions that he endeavoured to answer were:—

- 1 What does the sea contain at a given time in the form of living organisms?
- 2 How does this material vary from place to place and from time to time?

. All living organisms in the sea fall into one of three groups, though many pass one stage of their life history in one group and another stage in a second group.

The three groups are the Swimmers (Nekton), the sedentary forms (Benthos), and the drifters (Plankton). The latter group, the Plankton, includes those for the most part microscopic forms of life which drift passively in the surface layers, and upon this group all marine life ultimately depends. It comprises such diverse forms as crustacea, diatoms, worms, infusoria, and, strange as it may seem, the bulk of marine life is included in it. A few slides will show us more than anything else what the Plankton is like. These microscopic plants are able to manufacture—in the presence of sunlight—organic substance from the inorganic materials with which they are surrounded. They are eaten by the smaller planktonic animals, these in turn by larger forms, these by fish, so that we have a complete series of links between these minute forms and our fish food supply.

. If, then, we can estimate the volume of plankton, we can get an approximate idea of the yield of the sea in organic substance. This estimation was originally undertaken in the Baltic and North Seas, and it has subsequently been extended to other areas, so that we are able to compare one locality with another. Hensen's method is based on the careful collection of samples of plankton in a known volume of sea-water, and although there are doubtless some sources of error in these experiments—as in all scientific work—yet the results are sufficiently reliable to justify quantitative estimations of marine productivity. Many nets have been devised by Hensen and others for this purpose. The most satisfactory is the vertical net, which is constructed to capture the whole of the plankton, in a given volume of sea-water.

There are four methods of estimating the plankton, namely, by weight, volume, chemical analysis, and enumeration of the individual constituents, the last being an adaptation of the blood-counting methods of the physician. Assuming our estimations have been made, we are in a position to consider and compare results.

In the first place, coastal waters are much more productive than oceanic areas. This is due to the fact that the inorganic food material necessary for the planktonic plants is much more abundant in the vicinity of the land. There is considerable seasonal variation; at one time of the year the

animal constituents predominate, while at another time the plants are more abundant. It follows that analyses of the plankton vary with the season. In North European waters at the commencement of the year the plankton is, relatively poor, then with the increase of temperature and sunlight the Diatoms predominate, next come the fish eggs and larvæ. After the fish eggs and larvæ, the animal constituents come into prominence, with occasional large swarms of gelatinous algæ and jelly fish. In late autumn and winter the diatoms again predominate. Since the organic matter per unit surface of sea can be collected and analysed, it follows that comparisons can be made with a similar area of cultivated land. The autumn plankton of the Baltic, for instance, is intermediate in chemical composition between rich pasture and lupine. The Peridinean constituents come between rye straw and good grass hay. Diatoms—apart from their shells—resemble pea seeds. The crustacea of the plankton are analogous to the oyster.

According to Biebahn and Rodewald, the productivity of cultivated land is equal to 179 grams per square metre. Hensen estimated that the plankton productivity of the West Baltic was 150 grams per square metre. The fertility of the sea is thus, according to this comparison, about 20 per cent. less than that of the land. Now, while the plankton may not inaptly be compared to pasture, let us compare the results of the utilisation of this pasture with that of the land. Biebahn estimated that cultivated land produces 83·5 kilograms of beef per hectare per annum. In 1904 it is estimated that there was caught in the North Sea not less than 951,900 tons of fish, an average of 17·6 kilograms per hectare. It appears then that a large uncultivated water area is less productive than cultivated land. Uncultivated foreshore on the west coast of England produces from £6 in the case of cockles, to over 4,000 in the case of mussels, kilograms per hectare. Cultivated water areas, such as a carp pond or a mussel bed, produce from 164 in the case of the former to over 8,000 in the case of the latter, kilograms per hectare. It follows that cultivated water areas are capable of yielding more nitrogenous food material than similar land areas, and the same is probably true for uncultivated water areas. If we imagine the waters of the North Sea were to suddenly disappear, we should find every square foot of the bottom heaped up with animal life, not only bottom and surface living fish, but a huge mass of

invertebrates, all smothered under a dense mass of plankton. The production of organic matter on land is confined to a thin surface layer of soil, whereas in a sea production goes on through a stratum, the average thickness of which is not less than 200 feet.

Another striking result obtained by the quantitative plankton method is the conclusion that tropical seas are less productive of life than are temperate. It is true that in tropical seas there is a greater variety of marine life. Both fish and invertebrates are more varied and their colour is more vivid and ornamental, and one is apt to imply from this that there is in the aggregate a greater abundance of life, but there can be little doubt that the reverse is actually the case. In every case a comparison of tropical plankton hauls with those of temperate and colder regions shows unmistakably that the former are relatively poorer.

Why is this?

The reason is to be sought in the examination of the food constituents of the planktonic plants. All plants require certain chemical elements as food, for instance, carbon, hydrogen, oxygen, nitrogen and others; and it follows that if any of these elements falls below a certain minimum, plant growth and reproduction are no longer possible. Let us consider one element—nitrogen, which is an essential for plant life. Nitrogen compounds are present in the sea in exceedingly small quantities, and most probably their abundance is the controlling fact in plant production. So far as our results go, nitrogen is less abundant in tropical than in temperate seas, there is less, for instance, in the Mediterranean than in the North or Baltic Seas. The reason for this is that probably in the former seas a considerable decomposition of nitrogen compounds takes place owing to the action of denitrifying bacteria. Brandt, in 1898 predicted from theoretical considerations the presence of these bacteria in the sea; they were previously known on land, and 1902 Baur discovered them in the Baltic and Gran in the North Sea. These bacteria reduce nitrates to nitrites, these to ammonia, and lastly to free nitrogen, which is liberated to the atmosphere. These bacteria are more active at higher temperatures than lower, and from the investigations of Baur, the details of which I will spare you, it seems certain that they are more active in tropical than in temperate or sub-arctic regions. Hence a destruction, or rather a diminution, in the supply of a most

important food-substance goes on in tropical waters, and it is only in cold regions that great fisheries are found, though this does by no means exclude the possibility of establishing successful fisheries under proper management in tropical waters.

I can do no more than hint at the connection between hydrographical observations and the fisheries. It is probable that the movements of large masses of water of identical physical characteristics are correlated with the movements of shoals of fish. The characteristics which are at present being investigated are salinity, temperature and gaseous contents. The water samples are collected by a specially devised water bottle, and subsequently analysed on shore.

A connection between hydrographical conditions and successful fishing has been established in the case of the great east coast herring fishery off the British Isles, of the herring fisheries of the Skaggerrak, the fisheries of Barents Sea and of Iceland. All of these fisheries are correlated with certain definite physical conditions, and if these conditions fail in any year, then the fisheries fail also.

In conclusion, it is to be hoped that the efforts of the Bengal Government to explore the waters of the Bay may lead to the discovery of profitable fishing grounds as well as to the establishment in the Province of some organisation for the scientific study of marine biology and allied problems in Indian waters.

FISH INDUSTRY FOR INDIA.

*An article which appeared in the Indian Trade Journal of
the 24th June 1909.*

It has been pointed out more than once that the Indian Ocean teems with some of the finest fish in the world, and every student of India knows that this is a fish-eating country. Taken together, these two facts would seem to indicate that a very large trade might be done in fish. But, instead of developing such a trade ourselves, we are content to place our orders for a considerable percentage of our fish supply in foreign countries. During the official year 1908-09, for example, India imported not less than 25,573,428 lbs. of salt fish, valued at Rs. 27,58,839. This outlay, however, does not at all represent the full extent of our fish bill, for we also imported large quantities of canned fish, but the value in this case is not shown separately in the Customs returns.

Backward as the fish trade is, it cannot be readily doubted that it will one day be one of the important industries of India. Something has already been done by the trawler *Golden Crown* to show the extent of the fish supply in the Bay of Bengal; similar work is in progress in Rangoon; and the experimental preservation and curing of fish is making headway in Chepauk, Madras. In order, however, to bring the possibilities of the fish industry to the knowledge of those who may be on the lookout for a suitable opening for capital, Sir F. A. Nicholson, Honorary Director, Madras Fisheries Investigation, has issued an instructive book, which he modestly calls a "pamphlet," on *The Preservation and Curing of Fish*. It is published at the Government press, Madras, at Rs. 1-4 or 2s. per copy. In this book the author deals with the fish industry from every point of view, which his extensive travels over the fisheries in Japan, America, England and the Continent enable him to do with precision; and those interested in the technical details of this industry cannot do better than provide themselves with a copy of the work. The author seems to take for his text the fact that fresh fish cannot under present conditions be carried to the masses of the people, outside of a narrow belt of country bordering the sea, at the low prices which alone they can pay, because we do not at present know how to keep fish fresh and good for more than a very few hours without the use of ice, and

the cost of ice is prohibitive for all save the well-to-do. In an article in the *Indian Trade Journal* of November 19th, 1908 (page 176), we described a process of packing, by means of which the trade in fresh fish might be expanded considerably; but, so far as the masses are concerned, good cured fish must for years to come be the staple fishery product to which special attention should be paid. Sir Frederick Nicholson tells us, however, that it is certain from evidence obtained (1) that the demand for fresh fish is far greater than that for cured fish, and that no one will buy cured fish if fresh fish in fair condition can be obtained; (2) that the potential demand for fish of either class is far greater than the present supply; and (3) that the quality, whether of fresh or cured fish, is very often poor and not infrequently bad. He thinks that the marketable quantity and quality of the fish supplied could be improved by scrupulous cleanliness in curing and also by the judicious use of preservatives, such as salt, smoke, vinegar, and boric acid. Of course, there are strong objections in some quarters to the use of boric acid as a preservative, but Sir Frederick Nicholson is strongly of opinion that this acid has been very much maligned without just cause. The function of preservatives, he says, is to prevent decay and, consequently, the formation of deadly ptomaines and toxins, some of which are as virulent as the snake poison which they resemble. Preservatives, such as boric acid, inhibit or destroy germs and enormously lessen the chances of disease. Consequently, he urges, the use of preservatives is necessarily beneficial, unless the preservatives themselves are more deadly than the poisons which they prevent; but this, he thinks, reduces the argument against them to an absurdity, since food preservatives are mild and practically innocuous, while the toxins are deadly. It is a question, therefore, of plenty of good, wholesome, and cheap food procured with the help of preservatives, or of a scanty supply of less wholesome and often actually poisonous food without preservatives. He maintains that the chances of harm from using preservatives are to be considered negligible because (1) after curing is effected only a portion of the amount applied remains in the food; (2) that this can be, and ordinarily is, largely washed away by steeping in water before or during cooking; (3) that fish will only be used occasionally as an article of diet by any given individual; and (4) that the ration of fish will seldom exceed a fraction of a pound. "It

is not," says Sir Frederick Nicholson, "so much a question of permitting or of not prohibiting new preservatives as of *compelling* their use."

Simple desiccation by the sun's rays is perhaps the simplest and cheapest method of preserving fish. Bacteria cannot act in the absence of moisture, and salt is used as an antiseptic and to hasten dryage of the tissues. Moreover, the nutritive value is mostly retained by simple drying, whereas much is lost in heavily salted goods through the extraction by the salt of nutritive fluids from the cells. This does not mean, however, that fish should be dried to a cinder, by which treatment its digestibility and nutritive quality would be lessened. The method requires no costly packing, and no expensive machinery, barrels, etc.

Of the various methods of preserving fish, that of smoking seems never to have found favour in India, probably because of the comparatively small need for fire in this country and the very general use made of cow-dung as fuel. It has, however, been recently proved by experiments that good smoked fish, such as mackerel, scer and pomfret, are highly appreciated by British troops and practically by all classes of Europeans—a fact that seems to show that there is a large and immediate market for this class of goods. Another branch of the Indian fish industry, if it may be so called, and one that has been completely neglected, is that of canning. A complete canning plant capable of dealing with 5,000 cans per day could be procured for about Rs. 6,000, and there is hardly any question that a ready market exists in practically all parts of the world for the finest grades of Indian fish. In this case the objection to preservatives does not apply for such substances are not necessary, the goods being simply packed in tins which are then hermetically closed and sterilised by heat. Drying, smoking and canning are three branches of the fish industry that seem to merit a good deal more commercial attention than they have yet received in India. All three, it may reasonably be supposed, should yield a fair return on the capital outlay, to say nothing of the valuable by-products in the shape of fish-oil, manure, and so forth. Those who would care to go more deeply into the subject should consult Sir Frederick Nicholson's book.

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